GOTTHARD GUNTHER

CYBERPHILOSOPHY

BCL-Reports

English Collection, not complete –

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COMPUTATION AND METAPHYSICS and A SHORT CV OF GOTTHARD GÜNTHER

COGNITION AND VOLITION

LIFE AS POLY-CONTEXTURALITY

CYBERNETIC ONTOLOGY AND TRANSJUNCTIONAL OPERATIONS

FORMAL LOGIC, TOTALITY AND THE SUPER-ADDITIVE PRINCIPLE

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NUMBER AND LOGOS

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CYBERNETICS AND THE DIALECTIC MATERIALISM OF MARX AND LENIN

Computation and Metaphysics

Rudolf Kaehr, Glasgow Winter 2000

„There is little doubt that our present thinking *machines are hardly more than wooden horses.“ Gotthard Gunther*

Beyond Marxism and Cybernetics

Gotthard Günther (1900-1984) was a man and a thinker of the in-between and frontiers[1]. This was not the result of his emigration from Germany to USA – he was not a victim lacking a Heimat – this was his decision as a result of radical thinking. However, he did not see himself as fitting within the contemporary movements of his time, rather he perceived himself as being much ahead of an arriving future.

Also one eyed he could see far more into the landscape of the future than most of us could ever see with three eyes.

For his colleagues at the BCL[2] he was a continental philosopher, for his philosophy colleagues in Germany he was an American cybernetician, for the GDR ideologists he was a western metaphysical idealist and for the BRD philosophers he was a dialectical materialist. For the German New Left he was a logical positivist, for the positivists he was a Hegelian transcendentalist. For himself he was a transcendental logician but then discovered that he was a dialectical materialist, but in the sense of Lenin and Schelling amphasizing the heterarchical polycontexturality of grounds. In his thinking he didn´t accept any compromise, but for his *special food* he had to go to a lorry drivers inn. *Günther* was never a name in the singular, they had always been called *The Günthers*: Gotthard and Marie[3]. He was a good friend of thinkers of very different origins like Ernst Bloch the Marxist philosopher at the time of his emigration in the USA and his main work *„Idee und Grundriss einer nicht-Aristotelischen Logik“*[4] written in the 50´s was supported by the Platonist at Princeton, Kurt Gödel.

Günther himself was never involved in politics. He liked the clear sky and the fresh air of his gliding and skiing. In the fresh air of the wintry mountains of New Hampshire and focussed with only one eye, he was able to make distinctions which would have been confused by more disturbance. This was the place he found to his radical metaphysical and logical decisions about the future of thinking. Back from the mountains down in the cities there was mismatches everywere.[5]

With the „Hyäne des Pentagon“ at the Checkpoint Charley

With his passion for skiing - he had to give up gliding - he became an academic spy, even a double spy; at least their were some people who liked to belief that. After he became a professor emeritus in1972 he gaves lectures in philosophy at the university of Hamburg and he made his home there. The Academy of Science in Berlin, former

1. Gotthard Günther, Selbstdarstellung im Spiegel Amerikas, in: L.J. Pongratz (Hrsg.), Philosophie in Selbstdarstellungen Bd. II, Meiner Verlag, Hamburg 1975, pp. 1-76
2. BCL: Biological Computer Laboratory, University of Illinois, Urbana, Ill., USA, 1957-1976
3. Dr. Marie Günther-Hendel, jewish, teacher and founder of a Free school in Italy
4. Gotthard Günther, Idee und Grundriss einer nicht-Aristotelischen Logik, Meiner Verlag Hamburg 1959
5. Gunther-WEB: www.vordenker.de and www.techno.net/pcl

Capital of the GDR, wanted his secrets about the newest developments of US cybernetics as developed at the BCL - they received from Günther a hard lesson about the necessity to change their dialectical materialism towards a transclassical operational dialectics. The US Air Force paid his trip back to the wintry mountains. Some philosophical reports about cybernetics in Berlin (Ost) were delivered. The BCL was known only by a few specialists in the West as well as in the East in the 70´s. Today it is the source of the new German ideology: Radical Constructivism, Second Order Cybernetics and Autopoiesis with Heinz von Foerster and Humberto Maturana as the leading figures.[6]

At this time - I invited Günther to the Free University of West Berlin and accompanied him to his lectures at the Academy of Science - we had a crucial point in common: both of us had to pass the mysterious Checkpoint Charley; now part of a museum. By passing this place of technological secrets Gotthard told me that he is a „Hyäne des Pentagon" (or that the other side told him this). I didn´t really understand, probably because I was hearing something sounding more like Princeton then Pentagon. I couldn´t believe that there could be any precious secrets at the Academy.

Also fully involved in multiple-valued logic and perfectly informed by the JPRS[7] Günther did not mention anything about the first implementation of a *ternary* computer in1958 by a Russian team at the Computing Center of the Moscow State University[8] but had to respond to a hard critique from the Moscow logician Alexander Zinovyev about some problems involved in his place-value system of logic[9].

Günther, a lifelong emphatic skier, earned his money as a research professor for the foundations and philosophy of computation and cybernetics[10]. Since the appearance of symbolic logic in the 30´s he was convinced that dialectics could only succeed and prove its supremacy over Aristotelian logic if it could find a formalism beyond all logical formalisms for its realisation[11]. He was one of the very first philosophical readers of the „*Introduction*" by the Polish logician Alfred Tarski.[12]Again that was in contradiction to the mainstream of German transcendental logic and philosophy. With the raise of Cybernetics in the USSR and its emphasis in the GDR by Georg Klaus, Manfred Buhr and Günter Kröber[13] there was

6. Realitäten und Rationalitäten, A. Ziemke, R. Kaehr (eds) , Selbstorganisation, Bd. 6, Dunker&Humblot, Berlin 1995
7. JPRS: Joint Publications Research Service, RAND Corporation, Santa Monica, Cal., USA
8. „*In 1958 the first full scale implementation of a ternary computer was completed by a Russian team at the Computing Center of Moscow State University, and named Setun´. It was used for some time, but both poor hardware reliability and inadequate software hampered its usage."* Computer Science and Multiple-Valued Logic, (ed.) David C. Rhine, North-Holland, 1984, p. 7, cf. Cybernetics and the Dialectic Materialism of Marx and Lenin, footnote 18, this book
9. Report on Zinovyev. In: Nachlass Gotthard Günther, 21. Kasten, Mappe 252, Staatsbibliothek Berlin
10. Gordon Pask, The Originality of Cybernetics and the Cybernetics of Originality, 1982, cf. footnotes 25 and 29, this paper.
11. Gotthard Günther, Logistik und Transzendentallogik, in: Beiträge zu einer operationsfähigen Dialektik, Bd. I, Felix Meiner Verlag, 1976
12. A. Tarski, Einführung in die mathematische Logik, Verlag Jul. Springer, Berlin 1938
13. *„Aus heutiger Sicht sind diese Versuche einer mathematischen Modellierung dialektischer Widersprüche bestenfalls von historischem Interesse. Sie haben weder die Philosophie noch die Kybernetik substantiell bereichert."* K. Günter Kröber, Kybernetik als mathematische Theorie dialektischer Widersprüche, in: Kybernetik steckt den Osten an - Wiener's Ideen in Osteuropa und der DDR, Kolloquium der Gesellschaft für Kybernetik e. V., Nov. 2000; cf. http://www.kybernetiknet.de/

a hope of some possible co-operations in the project of formalizing dialectics. After having given a lecture in Moscow Günther wrote one of his last works *„Identität, Gegenidentität und Negativsprache“* which tracks back to a lecture given 1976 in Belgrade. In this text Günther makes a step beyond the dichotomy of number and logos in introducing the concept of a new type of language for the notation of non-designational realities.[14]

We know at least since his book *„Das Bewusstsein der Maschinen“*[15] that Günther was proud to be on the payroll of the US Air Force Office of Scientific Research. This fact was surely one of the main reasons why he was totally ignored by the German New Left Movement. I remember a wild night with some Maoist comrades in West Berlin. I told Alfred Sohn-Rethel, then a late member of critical theory, he just arrived from exile in Birmingham, U.K. that by the irony of history the real thinkers of dialectics are not in the revolutionary underground of a socialist country but at the BCL sponsored by the US Air Force.

Since the very beginning of his academic life Günther was interested in the philosophy of history. It is no surprise that there are several unpublished papers and book manuscripts about Russia and Marxism of the former USSR in the Nachlass[16].

„Cybernetics and the Dialectic Materialism of Marx and Lenin“[17] is not simply a literal translation of the german paper, from a lecture at the University of Cologne in 1964, but a transformation for the purpose of the US reader. And this English version also exists in several forms and intentions.

„Das Bewusstsein der Maschinen“ first published in 1957 and then in 1963 with a new chapter *„Idealismus, Materialismus und Kybernetik“* gave as some of his Western friends thought, dialectical materialism too much of a positive image. His answer was that he took both Apostel Paulus and Lenin with the same seriosness. When attacked by a readers-letter in *Astounding Science Fiction* he replied that it is more dangerous to be a metaphysician than to be a Marxist in the USA of today (McCarthy era).

With the Science (Fiction) Avantgarde

Gotthard Günther was always into techniques. Not only was he involved in the science fiction avant-garde with John W. Campell Jr. and published in *Astounding Science Fiction* and *Startling Stories* in the 50´s he also was the first to introduce American science fiction to Germany and he had a license for professional gliding[18] and skiing. All this was too early for the Germans and the books *„Weltraumbücher“* published by Karl Rauch Verlag Düsseldorf 1952 had to be taken off the shelf. It was surely enormous luck but perhaps not a total surprise that Warren Sturgis McCulloch[19] discovered

14. Gotthard Günther, Identität, Gegenidentität und Negativsprache, in: Wilhelm R. Beyer (ed.), Hegel-Jahrbuch 1979, Pahl-Rugenstein, Köln 1980, pp. 22-88
15. Gotthard Günther, Das Bewusstsein der Maschinen, Eine Metaphysik der Kybernetik, Agis Verlag, 2. Aufl., Baden-Baden1963
16. Gotthard Günther, Die amerikanische Apokalypse, Kurt Klagenfurt (ed.), Profil Verlag München, Wien 2000
17. this book
18. Phäidros und das Segelflugzeug. Von der Architektonik der Vernunft zur technischen Utopie. Gespräche mit Claus Baldus. In: Das Abenteuer der Ideen. Architektur und Philosophie seit der industriellen Revolution, Katalog zur internationalen Bauausstellung, Berln 1987, pp.69-88
19. Gotthard Gunther, Number and Logos, Unforgettable Hours with Warren St. McCulloch. In: Selbstorganisation, pp. 318-348

the importance of Günthers work for the logical foundations of cybernetics. He arranged for him a professorship at the BCL where Heinz von Foerster was the director.

Some years before *„Cybernetics and the Dialectic Materialism of Marx and Lenin"* Günther presented his fundamental work *„Cybernetic Ontology and Transjunctional Operations"*[20] on the 1 April 1962. Later published in the famous *„Self-Organizing Systems"*[21]. In this work he proposed a far-reaching formalization of dialectical und reflectional structures able to give a foundation for the implementation of subjective behaviours in machines. As a main step there is the formalisation of the transclassical operators of rejection and transjunction embedded in his morphogrammatics. With this background of polycontextural logic, his refutation of the whole alternative of idealism and materialism, which he had a deep knowledge of, and the design of a transclassiscal Worldview finally got its scientific foundation.

The Vietnam War and the End of Switching

When Günther was proposing machines capable of self-generating alternatives he was not only fully rejecting the alternative of Western idealism and Eastern materialism but trying to implement this same gesture into his idea of a trans-classical machine able of making refutations. His proposal *„A Study of new Development in Dialectic Theory in Marxist Countries and their Significance for the USA"*[22] ran in parallel to the complementary proposal for the *„Investigation of a Mathematical System for Decision-Making Machines"*[23].

Unfortunately lack of money and the need for more serious military R&D caused by the Vietnam War made a bitter end to this story[24]. After one last grant to complete the final archiving of the work done, the BCL closed in1976 with its *„BCL Publications"*[25].

„On the other hand, a machine, capable of genuine decision-making, would be a system gifted with the power of self-generation of choices, and then acting in a decisional manner upon its self-created alternatives. (...)

20. Gotthard Gunther, Cybernetic Ontology and Transjunctional Operations, Technical Report No. 4, Electrical Engineering Research Laboratory, University of Illinois, Urbana, Ill., Sponsored by: National Science Foundation, Grant 17414, Washington 25, DC.
21. Self-Organizing Systems, M.C. Yovits et al (eds.), Spartan Books, Washington, D.C., pp. 313-392, 1962
22. Gotthard Gunther, A Study of new Development in Dialectic Theory in Marxist Countries and their Significance for the USA, 13 pp., 1970
23. Gotthard Gunther, Proposal for the Continuation of a Mathematical System for Decision Making Machines, Under Grant AF-AFOSR 68-1391 for One Year From 15 October 1970, July 31, 1970
24. *"But then came the Mansfield Amendment. Most of the early work on cybernetics had been supported by the Office of Naval Research and the Air Force Office of Scientific Research. But in about 1968 the Mansfield Amendment put an end to research projects supported by the Department of Defense which were not clearly related to a military mission. It was intended that the National Science Foundation and other agencies would pick up the support of projects that had been funded by DOD. The problem of course was that these agencies did not have people who were familiar with the work in cybernetics. There followed several frustrating years of searching for new sources of support. Meanwhile Ross Ashby and Gotthard Gunther had retired and left the University. Finally in 1975 Heinz retired and moved to California."* Stuart A. Umpleby, Heinz Von Foerster, A Second Order Cybernetician. In: Cybernetics Forum, Vol IX, Fall 1979, N. 3, pp. 5-6
25. BCL, The Complete Publication of the Biological Computer Laboratory, Wilson, von Foerster (eds.), Illinois Blueprint Corp., Peoria, Ill 61603, 1976

A machine which has such a capacity could either accept or reject the total conceptual range within which a given input is logically and mathematically located. It goes without saying that by rejecting it the machine displays some independence from the programmer which would mean that the machine has the logical and mathematical prerequisites of making decisions of its own which were not implied by the conceptual range of the programme. But even if we assume that the machine accepts affirmatively the conceptual context of the programme qua context, this is by no means the same as being immediately affected by the specifique contents of the programme that the programmer feeds into it. If we call the first attitide of the machine critical acceptance of the programme and the latter naive acceptance, then it mus be said that the difference of their handling a given input in both cases are enormous. In the first case a conceptual and therefore structural context is rejected this does not necessarily imply that also the specific content of the programme are rejected. They still may be accepted, but moved to a different logical or mathematical contexturality."[26]

As an expert in skiing, for whom water skiing was a perversion[27], Günther wanted at least to have a transclassical computer system able of reflection, cognition and volition in his studio before dying. Skiing was his obsession and to build a transclassiscal computer his profession.[28]

Computers in the sense of transclassical cybernetics are not simply a tool or a medium but much more a radical new step in the understanding and transformation of the world and human nature in a trans-terrestrial world game.[29]

Computation and Metaphysics today

Questions of cracking identity in formal logical and computing systems are finally recognized now by leading computer scientists.

"Real-world computer systems involve extraordinarily complex issues of identity. (…)

Dealing with such identity questions is a recalcitrant issue that comes up in every corner of computing, from such relatively simple cases as Lisp's distinction between eq and equal to the (in general) undecidable question of whether two procedures compute the same function.

The aim of the Computational Ontology project *is to focus on identity as a technical problem in its own right, and to develop a calculus of generalized object identity, one in which identity -- the question of whether two entities are the same or different -- is taken to be a dynamic and contextual matter of perspective, rather than a static or permanent fact about intrinsic structure."*[30] Brian Cantwell Smith

26. Gotthard Gunther, Proposal for the Continuation, pp. 6-7
27. Personal remark. I gave him a beautiful book about water skiing from the American thrift shop Berlin.
28. Gotthard Günther, Lebenslinien der Subjektivität, Kybernetische Reflexionen, CD, c+p 2000 suppose, Köln 2000
29. Gotthard Günther, Beiträge zu einer operationsfähigen Dialektik, Bd. I-III, Felix Meiner Verlag, Hamburg 1976 ff.
30. Brian Cantwell Smith, SMITH-bio.html, 1999, cf. B.C. Smith, On the Origin of Objects, MIT Press, 1996

A Short CV of *Gotthard Günther*

by Eberhard von Goldammer

Gotthard Günther was born 15.06.1900 in Arnsdorf (Germany). He studied Indology, Chinese, Philosophy and Sanskrit. His PhD was the first version of his book "Grundzüge einer neuen Theorie des Denkens in Hegels Logik" which was published in 1933.

In 1938 Günther followed his wife who already emigrated from Germany in 1933; via South Africa Günther immigrated 1940 to the USA.

From 1942-1944 he became lecturer at the Colby College (Maine) and from 1944 at the Cambridge Adult Education Center.

1948 he became citizen of the USA. At that time he met J.W.Campbell who introduced Günther into the American Science Fiction literature and its importance to the American culture. Günther published some metaphysical-logical stories in ´Astounding Science Fiction´ and in ´Startling Stories´.

Remark for the reader:

If you want to have a look at Günther's more speculative approaches within the science fiction context vordenker holds all articles in another web, the Gunther web focusing on that stuff!

On the International congress on Philosophy (Brussels, 1953) Günther presented the first version of his concept of a transclassical logic "Die philosophische Idee einer nicht-Aristotelischen Logik".

1957 Günther published "Das Bewußtsein der Maschinen - Eine Metaphysik der Kybernetik" and "Metaphysik , Logik und die Theorie der Reflexion" as well as "Die Aristotelische Logik des Seins und die nicht-Aristotelische Logik".

In 1960 Günther met Warren S. McCulloch and a deep friendship began which was very stimulating for Günther´s further research studies.

In 1961 Günther became a research professor at the Biological Computer Laboratory - BCL (Department of Electrical Engineering, University of Illinois, Urbana), where he was working until 1972. In that time Günther developed his fundamental ideas about Poly-Contextural-Logic, Morpho- and Kenogrammatics.

Some publications of that period are:

Cybernetic Ontology and Transjunctional Operations;

Das metaphysische Problem einer Formalisierung der transzendental-dialektischen Logik;

Logik, Zeit, Emanation und Evolution;

Natural Numbers in Trans-Classic Systems.

After his retirement in 1972 he was working on a theory of "Negative Formal Languages" (Hegel-Congress, Belgrad, 1979 : "Identität, Gegenidentität und Negativsprache").

Günther died in the age of 84 at 29.Nov.´84.

Books:

Günther G.: Idee und Grundriß einer nicht-Aristotelischen Logik, Felix Meiner Verlag, Hamburg, 1978 (ISBN 3-7873-0392-8). This volume contains "Materialien zur Formalisierung der dialektischen Logik und der Morphogrammatik" by Rudof Kaehr.

Günther G.: Grundzüge einer neuen Theorie des Denkens in Hegels Logik, Felix Meiner Verlag, Hamburg, 1978 (ISBN 3-7873-0435-5).

Günther G.: Beiträge zur Grundlegung einer operationsfähigen Dialektik (vol. 1-3), Felix Meiner Verlag, Hamburg, 1976-1980.

Vol.1: 365 pages, ISBN 3-7873-0371-5

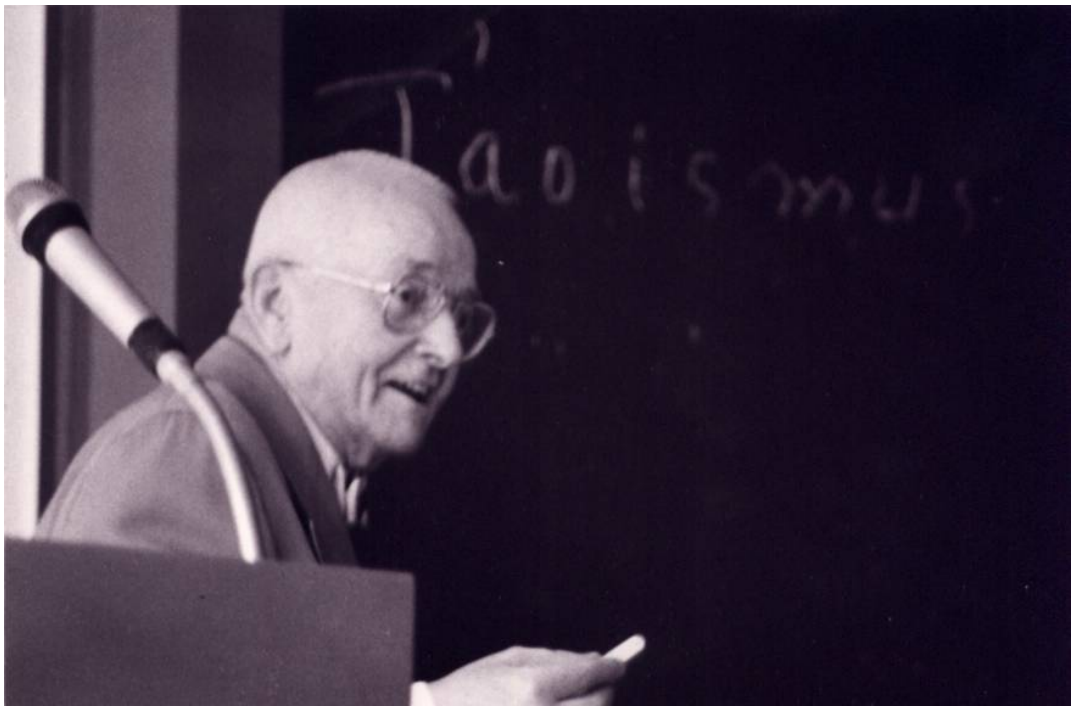
Vol.2: 336 pages, ISBN 3-7873-0462-2

Vol.3: 345 pages, ISBN 3-7873-0485-1.

Günther, G., in: Philosophie in Selbstdarstellungen II, Felix Meiner Verlag, Hamburg, 1975.

Günthers work can be considered as a milestone for contemporary philosophy and for a theoretical basis for modern cybernetics and systems theory.

See also: http://www.vordenker.de/ggphilosophy/gg_bibliographie.htm



Gotthard Günther giving a lecture at the University of (West-)Berlin in the early seventies.

Gotthard Günther and his favorite sport

Gotthard Günther[*)]

COGNITION AND VOLITION

A Contribution to a Cybernetic Theory of Subjectivity

Preamble

It seems to be beyond controversy that the novel science of Cybernetics involves the problem of subjectivity. If we speak of memory, intelligence and decision making in connection with machines we associate traits which, according to a very long and deeply founded tradition, belong to the domain of a so-called psyche, with the problem of computer design.

Philosophy and the humanities have dealt with the phenomenon of subjectivity for a long time. And these disciplines have always stressed the point that the problem of what religious thinkers call a soul cannot be treated with the methods of natural science and that all technical methods – we have known so far – are totally incommensurate with the character of spiritual manifestations. Especially memory was always considered an essential element of human spirituality. We have only to recall the role which Plato's anamnesis plays in the intellectual tradition of Western civilization.

The last decades of scientific development, however, have contradicted the prejudice that the faculties of intelligence, memory and decision-making belong entirely in the sphere of "subjective" life. It has been shown that certain processes of subjectivity which 50 years ago were still judged "transnatural" could be imitated by computing machines. So far, so good. Nevertheless, there is little awareness in cybernetic circles that the modest results which have so far been obtained by cybernetic techniques have raised a problem for which no answer has been found as yet because the problem itself has not been clearly recognized. Today we are facing the question: is the beginning dehumanisation and despiritualisation of the subjective faculties of living systems a superficial corrective process which merely chips off a few mechanical characteristics which were mistakenly connected with the subjective side of reality and which actually belong within the objective range of being or does Cybernetics aim at a basic revision of our traditional world concept which has been dividing reality into a natural and a supernatural sphere?

In the case that we deal only with a short period of corrective measures which do not touch the fundamental antithesis of the physical and the spiritual and of the basic relation between subject and object we may be satisfied with present cybernetic methods and the present paper of this author will then constitute a futile and superfluous effort. On the other hand, if the emergence of Cybernetics is to be taken as a symptom

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*) A short version has been published in: Cybernetics Technique in Brain Research and the Educational Process, 1971 Fall Conference of American Society for Cybernetics, Washington D.C., 119-135. The full text is published in: Gotthard Günther, Beiträge zu einer opertionsfähigen Dialektik, Band 2, Felix Meier Verlag, Hamburg [1]1979, p.203-240.

that we are at the eve of a total revolution of our traditional scientific world concept – a concept which looks at our world into an irreconcilable duality of form and matter, of meaningful information and physical energy, of subject and of object, and finally of theoretical reason and pragmatic will – then the present scientific methods employed in Cybernetics are woefully inadequate. They are totally insufficient because they are designed on the assumption that this classic duality which is mirrored in the general division between natural sciences and the humanities or moral sciences is still valid.[1]

However, no serious attempt has been made so far in Cybernetics to develop a general logical and mathematical theory of subjective life where life is not judged to be in its very core a supernatural phenomenon but treats it as an extension of physical events into patterns of an almost unimaginably high complexity.

As long as life is looked at as a supernatural essence the world the scientist deals with is a basically subjectless universe. And the very same rational methods which Western science has developed for the analysis of such a universe are now naively applied to a problem of a totally heterogeneous nature, namely to unravel the code of a universe which is an inextricable fusion of subject and object and where, according to a paper by Warren S. McCulloch of the year 1956 [2], we may design ethical robots, because a moral decision can be shown to be a direct extension of a physical event into structural patterns which are redundant from the viewpoint of mere physics but are nevertheless essential for the contact between subject and object. If we use our traditional logical and mathematical methods developed against the background of a cosmology which considered subjectivity as supernatural, totally extramundane and irrational to deal with subjective life as a self-referential process of nature and fully rational, this is approximately on the same level as if we asked the automakers in Detroit to use their tools to manufacture symphonies.

Cybernetics is now called upon to assist in solving social and political problems. So far the results have been more than disappointing. This will not change till we have developed methods germane to the problem of subjective life. When the Greeks developed their scientific methods – which, as far as the basic assumptions are concerned, are still ours – they did so within a conceptual ontological frame which radically excluded subjectivity. And they were well aware that their methods were only meaningful within this frame. The modern cyberneticist uses these very same methods but outside their legitimate frame. The result is that if analogues of subjective processes are designed into computer hardware the cyberneticist is consciously or unconsciously trying to make them as lifeless as possible. His methodical ideal is to unmask subjective processes of life as merely lifeless objective events instead of trying to retain as much as possible of their transphysical complexity. Hence the neglect of transclassical logic and the lack of interest in the theory of dialectics – the only praiseworthy exception being the work of Prof. Hector C. Sabelli of the Medical School in Chicago, if we ignore for the time being the cultivation of dialectic theory in the Eastern countries.

Since the present author is vigorously opposed to the prevailing methodological aim of total re-objectivation of life processes the following analysis of the fundamental relation between subjectivity as cognition and subjectivity as active volition is intended to be a contribution to a cybernetic theory of Life.

Part I

The problem of the antithesis of Reason and Will is as old as the spiritual history of mankind. There is an elementary knowledge, quickly acquired by the human intellect, that the happenings which take place in our Universe belong to two – as it seems – exactly opposite categories. We believe that we are able to distinguish quite clearly, on the one hand, impersonal objective events which take place in the realm of inanimate things and which are triggered by physical causes and, on the other hand, subjectively motivated actions of living organisms which appear to have a peculiar spontaneity. The manifestations or results of a subjective Will we call decisions. And although we cannot clearly say what the difference is between the causal connections which link the data of objectivity together and a driving will and a decision which emanates from it, thinkers have insisted since ancient times that there must be a fundamental difference.

A tradition of long standing says that the objective side of the Universe is fully determined by causality, but that living systems, although they also are partly determined by a strict nexus of cause and effect, have in addition a domain within which they seem to be undetermined and free. An inanimate object is wholly identical with itself and represents an unbroken contexture. For this very reason it is exclusively a product of determining causes. A living system, on the other hand, represents – according to the tradition and functionally speaking – a profound ontological duality. It is a system of contemplative cognizance as well as a source of active volition. In its cognitive capacity it is determined by its environment insofar as it can only recognize what there is – including its own fantasies and its own errors. As volition, on the other hand, it maintains a certain independence from its environment. It can change its environmental conditions within limits and negate the influences which the world presses upon it. This fundamental distinction between theoretical reason and pragmatic will is associated with antithetic pairs of other categories of which we shall name only a few. On the side of theoretical reason belong such concepts as observation, order, necessity and objective truth. Associated with pragmatic will, however, are the ideas of the Good, of Hope, of Purpose and of Personal Autonomy.

The human mind had hardly made these distinctions when the question arose: what is first in reality and has ontological primacy? Is it the object and connected with it theoretical reason, or the subject as the impersonation of will and as the activator of creative decisions? In the story of the Creation all existence is the result of the unfathomable Will of God. The world comes forth from Him, not as a logical or physical necessity but as a manifestation of a primordial decision that is groundless and deeper than all reason. This is the doctrine of the Primary of Will.

If we turn from the report of the Creation in the first Chapter of Genesis to the Gospel of St. John we learn, however, that not the will but reason is the primordial source of Reality. Because there we read: "In the beginning was the Word: and the Word was with God: and God was the Word."

We encounter the same ambiguous attitude toward the problem of the mutual relation between Will and Reason in the philosophy of Plato. On the one hand we learn through the mouth of Socrates that knowledge determines the will and that sin is basically nothing but theoretical error. On the other hand, in such dialogues as the Philebos or the Republic the point is stressed that the Idea of the Good is the highest, the very first and

the most general and the everything else (including Reason) derives from it. Finally, it is also possible to extricate from the work of Plato the ontological theorem that Reason and Will are dialectically speaking identical and that there is no primacy of either of it. This ultimate position comes very much to the fore in the latest period of Plato's thoughts, when he tried to connect his doctrine of ideas with the Pythagorean number theory equating the Idea of the Good with the Oneness of Being in general and hence with the arithmetical number 1. It is irrelevant whether Plato succeeded or not. At any rate, Plato's attempt was – seen against the background of the early development of Western Science – premature and therefore bound to be ineffective. The whole history of philosophy and scientific thought testifies to it, because the issues of the primacy of Reason or Will was never decided and the controversy oscillated for more than 2000 years between opposite solutions. Whenever a thinker proclaimed the primacy of Reason and the primordial rank of objective thingness some opponent was capable of demolishing such theory and asserting the primacy of Will and the primordinate ontological status of subjective decision. However, after having accomplished this the advocate of the primacy of Will suffered in turn the same fate of being refuted with the most convincing arguments and the pendulum swung back to the first position.

The controversy culminated the first time in the historic confrontation between Christian religion and Greek science. Taken as a whole the intellectual tradition of the Greeks decidedly favored the primacy of Reason and consequently a concept of the Universe that was basically rational and totally resolvable in terms of objectivity. In Christianity, however, the idea prevailed that the world had been created out of Nothingness by the inscrutable Will of God, the Father, and Reason or the Logos took second place and was personified by the Son.

A new confrontation took place in the rivalry of Thomism and Scotism during the high Middle Ages. According to Thomas the Will is determined by the knowledge of the Good, and the intellect is the *supreme motor* of the psyche. In contradicting Thomism Henry of Ghent, Duns Scotus and Occam argued that, if the Will receives its motoric impulses by Ideas and by the Intellect, it loses its basic character of contingency and its "power to the contrary". In order to be capable of genuine decisions the Will must be the "movens per se". A will can be sovereign only if it is not determined by the dictates of reason.

For Thomas even the Divine Will must be subservient to the Divine Wisdom which is its indisputable master. But Duns Scotus insists that God created the Universe as a manifestation of his absolute arbitrary will and if it had been his decision he might have endowed it with exactly the opposite properties. One of the most poignant formulation of this controversy is offered by Frances of Mayro who posed the question: Was God, when he created the world, bound by the laws of logic which limited his omnipotence or are these laws and their validity an expression of an arbitrary decision and he might as well have decided on different laws to be valid? On the ethical side Occam amended the argument by musing whether God might have decided that what we have learned to call sin might be the true content of the moral law of goodness.

That the controversy was never decided in favor of one or the other side since each party advanced equally valid and equally refutable arguments – is drastically demonstrated by the fact, that the issue turns up a third time at the highest level of

philosophy in the difference between Kant's and Hegel's metaphysical attitudes. For Kant there can be no doubt that philosophy has to insist on the primacy of Will and the absolute sovereignty of free decision (Categorical Imperative). Reason, according to Kant, cannot dominate the will because it is limited by an intrinsic weakness of built-in fallacies, the so-called "transcendental illusion". These fallacies are not a result of human incompetence and blundering but belong to the innate character of theoretical thought.

This metaphysical weakness of Reason is denied by Hegel, the philosopher of "Panlogism". The Will as the adversary of Reason has its highest manifestation in the realm of the "objective spirit" (objektiver Geist), i.e. in Law Morality and State. But above the objective spirit reigns the absolute spirit which is the self-reference of a Reason that is a law unto itself.

We shall not follow the further vagaries of the issue which has remained an unsolved problem. up to the present time and which must remain unresolved within the frame of the classic concepts of the world. For, as long as reality is subdivided into a natural and a supernatural sector, the problem cannot disappear. Subjectivity itself is then divided into a natural and a supernatural component.

If a problem is raised again and again and no solution can be found it is wise not to ask what separates the proponents of opposite viewpoints but to ask: what do they have in common? Because this is the point where the source of the disagreement must lie! And no matter how. much Greek scientists and religious thinkers of the early Christian era, or Thomists and Scotists and finally Kant and Hegel may disagree about the solution, there has been a marvelous agreement among the contending parties about the way to pose the problem. Neither side has ever doubted that Will and Reason are two distinct spiritual faculties of the subject than can be separately identified and put into opposition to each other like two warring leaders who meet on a battlefield with the aim to defeat the adversary. It has never occurred to the proponents of either side that they might not have anything worth while to fight about.

Occasionally, very occasionally, a timid doubt was voiced in the history of philosophy about the legitimacy of the problem; but such doubts remained without serious consequence because during the classic period of philosophy and science no tools were available to develop a theory which denied the assumption that Will and Reason are two capacities of the Mind, separate and independently operating.

This, however, is the position which we are going to take. Our Thesis will be: Will and Reason are the very same activity of the Mind, but seen from two different viewpoints. Or – to put it differently – Reason and Will or theoretical reflection on one hand and contingent decision on the other are only reciprocal manifestations of one and the same ontological configuration that is produced by the fact that a living system goes through constantly changing attitudes toward its environment. There is no thought unless it is constantly supported by a will to think. And there can be no act of volition unless there is a theoretical perception of something that will serve as motivation for the will.

A will that wills nothing but itself would have no objective that could trigger it into action; and a thought that is a mere mental image without a volitional process which produces and maintains it is equally inconceivable.

Under the circumstances it is understandable that we have as yet no scientific theory of decision making. If the will cannot be treated as a separate capacity and does not exist as such, there is no way to develop a separate theory for it and its mechanism of decision making. But, so the contradicting argument goes, we do have a theory of thinking which was originally conceived by Aristotle and developed and refined up to the present day. The answer to this argument is that it perpetuates a colossal mistake. We do *not* have a theory of the mechanism of thinking. If we had one we could have built computers with hetero-reference and self-reference that think like us long ago. But our present computers are only auto-referential. They have no awareness of the difference between their so-called thought processes and what these processes semantically refer to. In other words, they are not capable of hetero-reference, let alone self-reference. This is the best proof that we are still incapable to develop an exact theory of the process of thinking. What we have only acquired during the course of western scientific history is a mere theory of the *contents* or *results* of thinking, but not of the active thought process itself. To mistake our present day logic for a theory of the mechanism of thinking is about on the same level as if we confused our furniture with the movers who have placed it in our new apartment. So far all attempts to discover the laws of the subjective event which we call theoretical reflection have failed. And they failed for the very same reason why we never succeeded to develop a theory of will and decision making: because Will and Reason are not two independently operating capacities. They constitute a single faculty of subjectivity which, however, may assume contrary aspects under reversed ontological conditions.

Since the classic approach to identify cognition and volition separately in a closed unit of individual subjectivity has failed we shall approach the problem from a different side. We shall assume that the phenomenon of subjectivity, as manifested by thought processes and decision making, cannot be looked for inside the skin of an individual living body – be that animal or man. We propose instead the following theorem:

> *Subjectivity is a phenomenon distributed over the dialectic antithesis of the Ego as the subjective subject and the Thou as the objective subject, both of them having a common mediating environment.*

If we try to describe the situation from the viewpoint of a neutral observer we may say that we are aware of our own subjectivity by self-reference. In this self-reflective mental attitude one's own ego appears as a merely passive entity. We are aware of it in the sense of a pseudo-object, because all action which we ascribe to the living subjectivity is now absorbed in the self-referential process which has taken such "inward" direction. Thus the personal ego appears to our self-reflection as a *passive* object toward which our *active* attention is directed. One's own self is – so to speak – a "soul thing". However, if we turn from self-reference to hetero-reference and direct our attention toward our environment we meet subjectivity again, this time in the shape of the other ego, the Thou. But the Thou is not a soul thing to us, only the specific body the Thou is in liaison with presents itself to us as a thing. In our environment the category of thingness refers to physical objects only. The subjectivity in the shape of a Thou is conceivable to us and observable exclusively as the manifestation of an event which we may, in contraposition to the objective events which take place between inanimate things, call a volitional event as the expression of a subjective will which is not ours and which is totally inaccessible to us. What gives the Thou its peculiar

ontological position is that it has a physical location in our environment insofar as it must appear as an animated organic body occupying a specific place in time and space. On the other hand, it resists identification with this body which is reachable by methods of classic natural science and remains, as inner subjectivity, totally unreachable. In this respect it does not belong to our environment because by environment we mean something which is in principle within our reach, even if there are practical obstacles which may keep us away from certain parts of the environmental world. What gives this situation, however, an additional aspect of intricacy is the fact that we cannot rest satisfied with the simple formula that the subjective subject – which means our own ego – appears in a *mental* environment as an object of thought and the objective subject, the Thou, in a *physical* environment as a manifestation of will in the shape of decisions. In other words we cannot be satisfied with the primitive formula that our personal ego appears as the source of cognition and the alter ego as the font of decisions. We know very well that our own ego must also be considered as a main spring of decision and that no Thou could manifest itself as a decision making entity unless this process of deciding is motivated and directed by thought.

The key to the problem lies in the relation both versions of subjectivity have to the non-subjective environment and in our awareness that the I as the subjective subject forms with any Thou as the objective subject an exchange relation. Although everyone of us from his own viewpoint is the subjective Ego and any other subject is an objective Thou the situation is reversed from the viewpoint of any Thou. Seen from there all of us who claim to be subjective egos are demoted to the objective subjectivity of the Thou and located in an environment which is not ours – it only overlaps it – but belongs to the specific Thou who has taken up the role of the observer of us. This all of us know! And it means that the division which separates our personal subjectivity from the subjectivity which is mediated to us by our environment is – structurally speaking – only a replica of the division which we are aware of in our own selves as being the simultaneous source of cognitive concepts and volitive decisions. In other words: the brain as the organ of subjective awareness repeates within itself the relation between I and Thou as mediated by a physical environment. For this reason we shall, for the rest of this paper, ignore the existence of the Thou in our environment and assume for the time being and for the purpose of simplification a somewhat solipsistic attitude. We shall assume that there is only a solitary subject which finds itself the lonely living inhabitant of an otherwise lifeless cosmos. Even this epistemological attitude represents some progress compared with the traditional classic viewpoint where an observer maps a Universe which is totally devoid of Life – because he has excluded even himself.

After we have reached this point it is high time to reflect upon the question how the preceding ontological analysis could be relevant for brain research. There are two ways in which brain research can proceed. We can look at the brain as a mere physical piece of matter consisting of approximately 50 billion neurons and we can investigate how nature has constructed these neurons and how they arrest and transmit messages and store information. This is, of course, a legitimate procedure and it goes without saying that it is eminently necessary to proceed in this direction. However, this method has its limits. With the techniques available in this field of research it is, on principle, impossible to cross the borderline between objective events and subjective awareness. All research and analysis started in a given contexture is unavoidably and

unconditionally confined to the very contexture in which it started its moves. But objectivity and subjectivity are discontextural.

Moreover, there is a technical difficulty. The description of a neural system has to rely heavily on combinatorial analysis. But the number of neurons which are required to produce mental events is so high that combinatorial analysis will fail us in very relevant respects: it can be shown that, when we make the transition from the object to the subject, the neural system must display some properties which can only be described by recursive procedures. But these methods will not carry us far enough. We shall give one example: It is highly probable that the borderline between subjectivity and objectivity has some arithmetical relation to the maxima of the Stirling numbers of the second kind. If we ask for this maximum we want to know for which k at a particular n the value of $S(n,k)$ has a maximum.

This question can, for the time being, be answered up to the value $n = 95$. Beyond that number only estimates are possible. But to describe the mutual relation of subjectivity and objectivity adequately n would have to assume the value of 10 billion. And even that would probably not be enough because with 10 billion we refer only to the nerve cells of the brain and not to the additional nerve cells of the body.

In other words: there are not only theoretical but also practical reasons why research in the neural system of the brain will never reveal how the brain contributes to the solution of the riddle of subjectivity. However, there is another way to approach the problem. Instead of working uphill from the neuronic level we may ask: what is the highest achievement of the brain? In other words: what mental world concept does it produce? We can describe this world concept in semantic and structural terms and work down from there posing the question: how must a brain be organized in order to yield such images with their peculiar semantic significance. This types of investigation has hardly started, but it is as important and necessary as the other one. Part I of this essay was meant to lead the attention of the scientist in this direction and the following Part II will demonstrate how we can show by this method the basic link between subjectivity as cognition and subjectivity as a volitive process.

Part II

Since we are now purposely ignoring the problem of the Thou we discard within the frame of the present paper one of the strongest hints that subjectivity is an essential part of any environment. We let this question rest for the time being because the subjectivity of the Thou is not our subjectivity which emerges in self-reference. The Thou is always a product of hetero-reference, and it is our aim to show that even the subjectivity of the personal ego – apart from our knowledge about other subjects – is not something which is, so to speak, enclosed within an individual personality but is distributed over a living system *and* its environment.

The relation of a personal self to its environment may, according to everybody's experience, assume two basic aspects. Either the influence of the environment will be so overpowering that the self cannot help but conform and adapt to the forces which press upon it from the outside. On the other hand, the state of the environment may be such that it remains neutral with regard to the needs of the living system which it envelops.

In the first case there is no way in which the subjectivity of a living organism can exert itself as a process of decision making. It can only passively register the messages it receives from the outside and when it tries to describe its environmental world and its own position in it, it must do so in terms of physical causality and concomitant logical necessity. This means that the changing states of the subject will assume cognitive character and will be describable in terms of theoretical reason, the laws of which are dictated by the objective existence of the world as it is.

However, if we assume that the relation between a living system and its environment enters a state in which the environmental world does not positively influence the subjectivity which it harbors, then the subjectivity itself, in order to overcome this indifference, and in order to maintain its characteristics of Life, cannot help but enter into an active role. It is important to say that it must assume an active role and not only: it may be active. This is a basic criterion that separates inanimate from living matter. If in a specific case the world does not exert an observable positive influence on an entity which it envelops and the entity in question remains inactive we are inclined to assume that we are confronted by a case of mere indeterminacy which seems sometimes to occur within the domain of subjectless objectivity. However, if a system is structured in such a way that its own inner organization forces it to react positively to the neutrality of the environment by an act of self-determination, then we speak of a living system of subjectivity.

The point is that the world as an ontological totality, namely system or systems plus environment, is always fully determined. But the causal nexus may seemingly run into two directions. It may either start in the environment and propagate itself into the system to which it is environmental or it may give the appearance to have its starting point inside the subjectivity of a living system and carry over from there into the environment. In this second case the classic tradition speaks of the Freedom of Will. A semblance of partial indeterminacy of Reality appears only if we take a one-sided epistemological view of the world as a subjectless contexture of objectivity. This is exactly what the classical tradition of natural science has done and by following it to its ultimate consequences it has arrived at the theory of quantum mechanics where Heisenberg's principle of uncertainty has demonstrated a certain measure of indeterminacy in the description of the isolated object.

At this juncture it is necessary to point out that it would not be proper to talk of two chains of causality, one originating in the object inanimate and the other in the anima, insofar as all systems of Life have originally emerged from the very environment from which they have screened themselves off. The fact is that there is only one chain of causality originating from and spreading through the environmental world and being reflected back into the environment through the medium of the living system. But the law of determinacy expresses itself in two distinct modalities. We must distinguish between irreflexive and reflected causality. What we mean is that the chain of causality, by its passage through a living system, suffers a radical change of character. When Arnold Gehlen wrote his "Theorie der Willensfreiheit" (A Theory of the Freedom of Will) in the early '30s he drew attention to two basic facts about the volitive aspects of subjectivity. First – and here he followed the example of Leibniz – he argued that the freedom of will should never be interpreted as lack of causal determination in the physical sense but that it means a positive plus of determination engendered by the

living system and added to the physical conditions of the object. But Gehlen went even deeper into the problem by showing that freedom is never a matter of the materiality of the event but of its structural form. What will happen according to the physical conditions of the world as objectivity will come to pass anyhow as determined by irreflexive causality. There is no escape from it. The event per se cannot be avoided but its form is capable of modification. To put it differently: if we observe two events in the world and we say that one is an objective happening, exclusively determined by environmental physical causes, and the other event is a "spontaneous action" triggered by a free will we can only mean that both events, fully determined as far as objective causality goes, nevertheless differ – and differ considerably with regard to their structural form. A volitive action of a so-called subject involves a much higher structural complexity than we can observe in the so-called physical irreflexive causality in the object. But let us make no mistake about it – a process of volition is as causally determined as an avalanche that thunders down a mountain slope. What has produced the myth of a totally undetermined will is the fact that the transfer of causality from the object to the mechanism of subjectivity adds so much in structural richness to the causal nexus that it has the appearance that a totally new force emerged which seems to be utterly different from the chains of determination which links all objects together. We stated above that the world as a totality of object plus subject is fully determined, although if we look at the *isolated* object its determination does not seem to be complete, but there is determination. On the other hand if we look at the *isolated* subject its freedom or absence of determination does not seem to be total, but still there is freedom. However, if we assume that reality as an integration of objectivity *and* subjectivity is fully determined we might explain the situation by saying that the causality of the objective contexture of the Universe takes a feedback loop through subjectivity back into the environment. Yet we have to be very careful in making such a statement because the feedback we are referring to is of much higher structural complexity than what we observe as feedback in physical systems. The idea of feedback which we have entertained so far in computer theory does not involve the specific change in structural form which causality suffers when it passes through a system of subjectivity.

Since a volitive system needs an image of the world in order to make decisions and produce actions based on such decisions we may call the alleged freedom of will an "image-induced" causality. The objective causality of environment without such feedback through a volitive system is imageless. Since the classic tradition of science recognizes only the type of causality which is not filtered through an image it was unavoidable that the myth of a subjective power originated. A power which acts in a completely undetermined way, independent of and even contrary to, the causal nexus of the physical Universe. But let us repeat: unless we resort to mysticism which has no place in science, free will cannot be called lack of determination but is actually a plus of formal determining factors on the basis of increased structural complexity of the event. These factors must be added to the determining data of the subjectless Universe of classic tradition and after we have done so we will be entitled to say that the total of reality as the integration of subject and object is fully determined and as such a legitimate object of scientific inquiry and cybernetic design.

The classic concept of the Universe contains – ontologically speaking – black holes in the structure of reality which were scantily filled out by the products of a theory which claimed that our physical Universe is engulfed in a supernatural world penetrating this vale of tears occasionally and produces the aforementioned black holes of irrationality and of total absence of determination.

We pointed out above that the distinction between inanimate matter and living organisms is to be found in the criterion that a living system is inevitably forced to act in a situation where its behavior cannot be fully dictated by the environment. We shall now give the reason why such a duality of subjective attitudes may occur. An environment will always dominate a system of subjectivity in situations where the former displays a higher structural complexity than the system acted upon. However, there are other situations where the relation between a living system and its environment is characterized by the fact that the environment – as far as it concerns the subject – displays less structural complexity than the subjectivity which faces it. This means that, if we want to describe the possible attitudes subjective activity can assume with regard to the world which surrounds it, we have to contend with two inverse hierarchical (ordered) relations. In one case the outside world is on the apex of the hierarchy and rules unconditionally over the subject and in the reverse hierarchical relation the subject is sovereign and reigns supreme over the object. It is obvious that in the first case subjectivity will appear to us as a cognitive system. In the other it will manifest itself as volition. Our figures_1 and _2 may help to illustrate the mutual relations between subjectivity as cognition and subjectivity as volition. They are structurally speaking – mirror images of each other. It only should not be forgotten that the two figures refer to a solitary subjectivity and not to the distribution of cognition and volition over an uncountable number of centers of subjectivity.

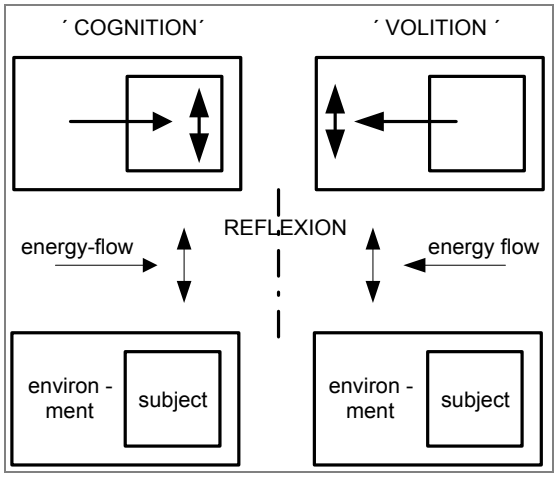


fig._1 fig._2

In figure_1 we have drawn a rectangle which contains a square and inside e the square a double-headed arrow. A second arrow points from the rectangle into the square. In figure_2 we have drawn the same rectangle and square, only the position and the direction of the arrows are now changed. The single-headed arrow now points from the square into the rectangle and towards the double-headed arrow which is now located in the larger oblong figure. Figure_1 represents in a very simple manner the relation of a subject to its environment if its life manifests itself as a cognitive system. In other words: Figure_1 refers to the pattern of Thought based on the perception of an outside world. In figure_2 the same system of subjectivity determines its relation to the environment in the form of decisions. It acts, not as a reasoning entity bound by laws of logic, but as a relatively spontaneous mechanism of volition. The one-headed arrow indicates the direction of the volition and the flow of image-induced causality. In figure_1 the environment represented by the rectangle causes an event inside the cognitive system. In Figure_2 the volition produces an event in the outside

world. The choice of our symbols is not quite fortuitous. The double-headed arrows indicate that the inverse flow of the events always heads for a structural configuration which is symmetrical, ambivalent and implies a. duality, in short an exchange relation. The single-headed arrows signify a unidirectional order. Our two figures show that the mutual relations of a cognition and a volition with regard to their environment are exactly inverse.

It goes without saying that figure_1 and figure_2 represent an abstract separation of the interlocking mechanisms of cognition and volition. In reality there is, of course, a constant interplay between the two and it goes without saying that one of them cannot operate without being continuously supported by the other. There is no thought without an essential admixture of volition and vice versa volition without an intrinsic component of theoretical awareness would be totally blind. For the time being, however, we shall ignore this necessary interplay and describe the functions of reason and will in the state of their artificial isolation which is depicted by our separate figures. Figure_1 represents essentially the ancient eidola theory of cognition as conceived by Democritos. According to him all things send tiny messages to the mind. These messages have the shape of infinitely small copies of the objects which we perceive; these copies or minute replicas of things enter our theoretical consciousness and in this way we are aware of the shape and of all other properties of the objects in the universe. It is highly significant that this eidola theory which found much acclaim in antiquity interprets the process of cognizance as one in which the cognitive system remains essentially passive. The Democritic subject of cognition requires hardly any activity since it does not receive a chaotic mass of sensations out of which it has to form by its own efforts mental images. According to Democritos these images are already preformed in the environment by the objects themselves. This environmental process is projected into the cognitive system and the latter has not to add anything to it. To use a modem analogy: The cognitive sector of the mind behaves like the screen in a movie theatre onto which the projector throws the images created by a film; the screen contributes nothing to the film, it merely reflects passively what is thrown onto it.

It is, of course, impossible to subscribe nowadays fully to this ancient image theory. But it contains undoubtedly an important element of truth insofar as it implies that the relation between the cognitive attitude of subjectivity and the environment is an asymmetrical or ordered relation in which the environment plays the dominant part. Cognition implies a hierarchy as an ordered relation of matter and form in which the world dictates to the mind what there is and the cognitive system has no choice but to accept the facts and to submit to them. This attitude of submissive Reason, when the latter is faced by the factual state of the world, is so deeply ingrained in us that scientists have always felt outraged by the remark of a famous philosopher who, after being told that his assumed facts were untrue is reported to have said: So much the worse for the facts!

It should be kept in mind that the relation between subject and object is always non-symmetrical and therefore an expression of a hierarchical order, whereas the relations between objects – by rigidly excluding subjectivity – always boil down to symmetry relations. It has frequently been pointed out that the laws of physics are expressions of a symmetry and wherever physicists encounter asymmetries they look for compensating phenomena which will reconstitute the lost symmetry. It can safely be

said that a Universe which is completely devoid of the slightest trace of subjectivity will with regard to structure always be perfectly symmetrical. And the description of such a Universe is the scientific ideal the classic tradition of science has been striving after. It follows that two-valued logic which governs the laws of Nature as a contexture of mere objectivity is based on a symmetrical exchange relation as represented in figure_3. This abstract structural pattern should not be confused with the classic Table of Position and Negation as is frequently done.

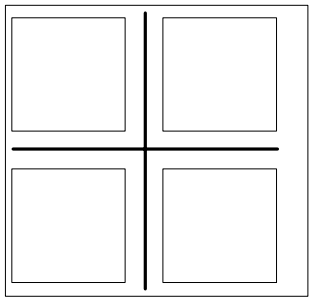


fig._3

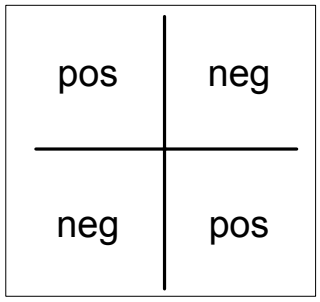


fig._4

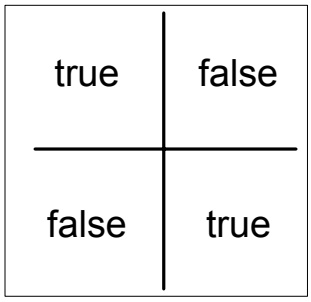


fig._5

Figure_4 stands for the negational Table of two-valued logic. Both Tables represent the same structural pattern of a mutual exchange relation, but the crucial difference is that in the first case we have a mere symmetry relation whereas in the second case this symmetry is burdened by a value occupancy of positive and negative. Mapping the relation of positive and negative onto the symmetrical pattern of mutual exchange means that, for the specific case of classic two-valued logic, position and negation should be considered strictly symmetrical and should subjectively be interpretable as the logical antitheses of true and false as written down in figure_5.

But it should always be kept in mind that the figures_3, _4 and _5 are, epistemologically speaking, not identical. What the figures_4 and _5 have in common with figure_3 is that they all represent symmetrical exchange relations. But the value occupancy of fig._4 tells us additionally that, if position and negation are mapped onto figure_3, then negation will conditionally assume a symmetry relation with position. But only in this specific case! It can be shown – as the present author has done in previous publications – that the relation of position and negation can also be asymmetrically interpreted because it is possible to increase the number of negation's whereas position remains always a solitary value. Figure_5 then indicates that, if and only if the condition of figure_4 is accepted, then it will be possible to interpret the relation of positive and negative as the antithesis of True and False.

It was necessary to point out these distinctions between the mere structure of a symmetrical exchange relation and its two aspects of possible value-occupancy to forestall the mistake that, when we continue to speak about mutual exchange relations, we refer to value-occupancies in the sense of fig._5, unless we say so expressly.

We shall now return to our discussion of figure_1 which sketches the basic situation of a single cognitive system in its environment. We shall continue to neglect the fact that there may be other cognitive systems with different centers of subjectivity. It is obvious that any system of reason – no matter whether it operates from the basis of our own or of an alien subjectivity – is not solely describable in terms of ordered relations but that

it must also incorporate exchange relations. And in a cognitive situation we have to look for the latter, not in the environment but within the confines of the cognitive system itself – in its mental (conceptual) space, so to speak. The exchange, in fact, provides the most elementary structural basis for all cognitive processes because it can be occupied by logical values as the Table of Negation in any textbook of elementary logic shows.

Unfortunately not even one of the modem treatises of elementary logic gives any explanation of the ontological significance of the classic Table of Negation. We shall try to fill this gap. Objective Being as a totally subjectless (irreflexive) contexture is one-valued. Nothing can be said about it but that it is. In contrast to it we find that the logic which is expected to map the structure of objective Being is two-valued. The reason for this difference is that mapping is a process and one cannot describe the mental movement and change which such a process involves by a single value. A minimum of two values is necessary. On the other hand, there should not be more than two. Because if, let us say, three values were at our disposal – which means one position and two negations – then the relation between position and negation in general would be an ordered one. Only if we have a position and one single total negation the relation between the two will form a symmetrical exchange. And exactly this is required if we want to provide the opportunity for a process where assertion can be replaced by negation and negation transformed into assertion. If the relation between position and negation were an ordered one, as is the case in many-valued systems, then our logic could not describe the ever changing relation between the various contents of thought. An ordered relation describes what is. Which means that many-valued systems are formalized ontologies and not descriptions of subjective processes of thought or cognition. It is this indifference against the ontological significance of Tables of Negation which renders cyberneticists so helpless when facing systems of many-valued logic, and which has so far prohibited the application of trans-classic logic to computer design. The cognitive mind is a living system only as long as the subjectivity of its reasoning is suspended between the two poles of a symmetrical exchange relation. This relation provides the freedom to err, a. freedom which the mere object does not have. And it is the fact that all living subjectivity is cognitively based on the total symmetry between position and negation which makes the connection between cognition and that which is recognized something more than the plain causal nexus which Democritos' theory of knowledge suggests.

But in order to map its environment the subjectivity requires the chance to express also the hierarchical relation between itself and its environment. This is what makes the theory of classic logic (as distinct from a mere logical calculus) so extremely difficult because its symmetry laws mean implicitly much more than they expressly state. What they expressly state is the formal structure of subjectless objectivity mapped in a conceptual space. What they indirectly and latently also imply is the dependency of the cognitive system on its environment. But this relation is only implied and not expressed and, in fact, not positively expressible – in the laws of two-valued logic. Thus we observe a fundamental insufficiency in this logic: it cannot bridge the chasm between form and content. For the classic tradition the relation between form and content or matter appears to be hierarchical. It points to the distinction between subject and object. This tradition tells us that subjectivity is form and objectivity matter. But the image of the world that cognition maps within its mental space does not reflect in its symmetry

structure any essential imbalance between form and matter. Cognition implies subjective or logical symmetry. This is why we have placed a double-headed arrow inside the square of fig. 1 as a symbol of symmetrical exchange. Everything inside the cognitive domain of consciousness – no matter whether intrinsically asymmetrical or not – is pressed into the Procrustean bed of symmetry.

However, a living system finds itself in an additional position relative to its environment, where it behaves not cognitively, but as a volitive mechanism. In the volitive situation the messages sent by the environment and telling the mind that things are so and so (and that the mind should behave accordingly) have become totally irrelevant. Figure_2 refers to this situation in which a system of subjectivity does not behave cognitively relative to the environment but with subjective volition. This is the point where the issue of Free Will enters our analysis of the relation between subject and object. What we have drawn in fig. 2 has been illustrated in the Middle Ages by an amusing mental experiment usually referred to as the story of Buridan's Ass. John Buridan, once rector of the University at Paris and co-founder of the University of Vienna, argued that, if an ass were placed equidistantly between two bundles of hay of absolutely equal attractiveness and all other conditions to choose either bundle were precisely equal, then according to the theory of determinism the animal would have to starve to death. Because if every event in the world were completely determined by its conditions the ass would be incapable of even moving its head towards the one or the other bundle – let alone to eat from one of them. But common sense and experience tell us that the ass will not starve but start feeding from one or the other hay bundle. The conclusion is that under the given conditions the ass must have freedom of choice. As a living system it cannot be totally determined by its environment. This the animal demonstrates by making a decision of its own. Which means, according to the classic theory of determination, the ass must be capable of acting from lack of objective determination.

It is interesting to know that Buridan himself remained personally undecided between determinism and indeterminism.

The idea of a volitive action of a living system springing from a lack of determination in this physical world is only possible if we accept the ancient tradition that the soul is a citizen of a supernatural world which dwells only temporarily in the physical cosmos and, if it does so, it carries with it its powers of spontaneity which have their roots in those transcendent regions of the spiritual. If we discard this concept, then the idea of a volitive action of a living system which arises from a mere lack of physical determination is inconceivable. If we look at the problem from the cybernetic viewpoint that the Universe is aware of itself, not as a totality in the sense of pan-psychism but aware of itself in certain preferred localities with a highly complex structure, then we may say – without resorting to the idea of supernatural and irrational influences – that the necessity of maintaining the status of a level of complexity, which is higher than that of the environment, will produce events in a system of awareness if a situation occurs in which the structural difference between system and environment is not maintained from the outside. The latter is the case in the situation, which is described in figure 1, where the distinction between the living system and its environment is indeed maintained from the outside. Thus the attitude of a cognitive system is basically contemplative.

On the other hand, in the case of Buridan's Ass the environment presents itself to the living system in the shape of two hay bundles constituting physically a symmetrical exchange relation. In other words: the environment does not provide the volitive system with a directive situation from which the will can take its orders while maintaining at the same time its subjective distinction from the outside world. It must be understood that a symmetrical interchange relation is absolutely neutral in itself relative to the distinction between subject and object. In the cognitive attitude of the subject the exchange relation made possible and triggered a mental movement which resulted in the mapping of the world. But in the case of Buridan's Ass and the two equal hay bundles the existing exchange relation triggers a volitive process which results in a physical act within the realm of objectivity. The ass when facing the two bundles cannot remain in a situation of suspended choice where the outside world does not offer him a bona fide objectivity in form of a thing but feeds him instead an alternative between two things. And since we know that the relation between subjectivity and its environment contains also an element of order it is the animal in this case which has to supply this order by making a choice. If the animal turn s from the alternative itself to one of the alternates it establishes an ordered relation between itself and the chosen object relegating the other alternate into the realm of the mere potential which might have been chosen but was not. As long as Buridan's Ass is facing a choice it has not established itself as an autonomous subject versus an objective world because the world as a mere alternative of possibilities has no objectivity either. Only by making a choice and choosing one of the hay bundles the ass identifies what is objective for it and what is relegated to the limbo of a mere potentiality.

At this point an objection has to be taken care of. The classic thinker will insist that both hay bundles are equally real at all times, no matter what the ass decides to do. It would be false to deny the validity of this argument, but it misses the point we are trying to make. The statement that both hay bundles are equally real at all times belongs within the context of our fig._1. It is a judgment originated in the system of contemplative reason. And in this system undoubtedly correct. But we are now discussing fig._2 because we are analyzing a volitive and not a cognitive relation between a system of subjectivity and its environment. This volition manifests itself in the case of the ass by the fact that it eats from one bundle of hay at a given time and not from the other. The one which is disdained at the given moment remains for the will in the realm of a mere possibility of being eaten. And while it is in this state the will makes no direct contact with it as a representation of objective reality.

The lesson to be learned is that the ontological judgments which govern the cognitive relation of the subject to the world may motivate the volition but they do not control the mechanism of volitive action. The structural reason for this difference lies in the fact that the symmetrical exchange relation which, in the case of figure 1, is a mechanism of reasoning within the conceptual space of subjectivity where it is treated as an alternation of values, is, in the case of figure_2, projected into the environment where in Buridan's example it turns up as an exchange relation between two objects. Since the alternative is. now a property of the environment the mechanism of volitive subjectivity must express itself as an ordering process where we have only the choice between exchange and order. And we repeat: the exchange mechanism is the one which the cognitive subjectivity uses to set itself in motion.

We may now say that a system of subjectivity is a mechanism – albeit not a classic one – in which two interacting programs of cognition and volition regulate its relation to the environment concurrently. In one program the living system has to behave under the supposition that the environment represents the superior force of the factum brutum to which reason has to submit; now subjectivity finds itself placed at the bottom rung of a hierarchical ladder as long as the connection between subject and object is cognitive. In the other, the volitive program, the environmental objectivity is merely a nebulous field of potentialities which only the Will can transform to solid objective realities.

Being suspended in this unresolvable duality is the price the Universe has to pay when, as a cosmic synthesis of subject and object, it is aware of itself, with an awareness, however, which is restricted to certain ontologically preferred localities which show a highly complex structure. For classic Reason which looked at a subjectless Universe from a supernatural locus outside the world there was always the idea of the absolute truth that objects had identity per se and could be described as such without any regard to the describing subject. It was, of course, admitted that human reason which had strayed into this world by an ontological accident, so to speak, could for practical reasons never produce a totally accurate description of the object. This remained an unattainable ideal, but scientific efforts could at least converge towards it.

For the cybernetic viewpoint which looks at the cosmos as a compound structure of subject and object there is no such absolute truth per se and no absolute objectivity conceivable by a cognitive subject. We can only state that the Universe offers to our subjective awareness, split into a cognitive and a volitive sector, two complementary aspects of objectivity which are accessible to us only by hermeneutic methods because the world may either be interpreted as a system which dominates subjectivity after having created it as the last product of evolution and emanation. Or the world may be interpreted as an indifferent and inert substratum of mere potentialities out of which the subject as the font of volitive action produces that which Utopian thinkers of all times have called the realisation of the world as the Realm of Freedom. This second aspect is the one from which such disciplines as the social sciences and the humanities emerge.

Both interpretations are equally valid but equally incomplete – when one is used without the other – to interpret the totality of a Universe endowed with Life. So far these two aspects have been kept carefully separated and there has been much talk about a duality of methods of enquiry (Methodendualismus). However, by using hermeneutic methods it is possible to define a structural link between them on the basis of the thesis that cognition and volition are precisely complementary aspects of subjectivity. Part III of this paper will try to give a first description of the as yet missing link.

Part III

We noticed that the relation of a system to its environment could be twofold and describable in terms of order and exchange. We are entitled to say that the environmental (material) world represents order and subjectivity a lack of order. This is the classic viewpoint where the subject has been traditionally considered the source of all error, unreliability, and even sin. If we translate such terms into a rigorously abstract language we can only say that subjectivity is a symmetrical exchange relation in the state of suspense where it is not yet decided which alternate will be chosen.

Complementary to this viewpoint is the other one which states that subjectivity (as pure form) is the potential source of all order and the environmental world a form- and orderless region of mere potentialities. Again in abstract structural terms: for the complementary viewpoint the environment shows the pattern of an exchange relation and systems of subjectivity display a degree of order and organization which is not to be found in the relations between mere objects.

This leads to the conclusion that the distinction between subject and object, when expressed by an impartial observer in purely logical terms, is nothing but a specific expression for the universal distinction between form and content of a form (materiality). In view of the complementarity between cognition and volition which we have observed it does not matter whether we say: the symmetrical exchange relation is the structural basis of all form and differences in materiality must reflect themselves in ordered relations; or whether we reverse our viewpoint and argue that an exchange relation is akin to material content, because an exchange relation involves the problem of contingency and that order relations always describe structural forms. The first viewpoint simply emphasizes cognition and the second volition. Because if we say that the exchange relation and its symmetry refers to mere form we mean that all formal logic is based on the symmetrical exchange of affirmative position and total (one-valued) negation. But if we reverse our attitude and state that an exchange relation with its implied contingency is akin to the material content we mean – if we stick to Buridan's example – the physical coexistence of the two hay bundles and the choice they offer. And generally speaking we mean that the contexture of subjectless physical objectivity is governed by the law of symmetry.

After having rid ourselves of the prejudice that the relation between form and content constitutes an irreversible order we have arrived at the crucial point where we may consider the theoretical possibility of a calculus which links cognition with volition – or to put it in more abstract terms – which is based on the principal exchangeability of form and the material content of form. This is, within the domain of logic, the very same question which has recently become so extremely important in the eyes of cyberneticists. We refer to the very urgent problem of the relation between the flow of energy and the acquisition of information. It has recently been noted that the use of "bound information' in the Brillouin sense of necessity involves energy. The use of energy, based on considerations of thermodynamic availability, of necessity involves information. Thus information and energy are inextricably interwoven.

If we transfer the terms information and energy to the theory of a system of subjectivity we may confidently replace them by the terms cognition and volition and assert that what is – logically or structurally speaking – valid for the interrelation of information and energy will logically and structurally also be valid for the linkage between cognition and volition. But both complementarities, energy / information on one side and cognition /volition on the other, must be related to each other on an ultimate level of abstraction which defines the relation between symmetrical exchange and non-symmetrical order.

It may be useful at this point to remind the reader that the relation between exchange and order is the formal equivalent of the ontological relation between form and (material) content. But not in the sense – as we must emphasize again – that exchange

stands for form and order for matter or vice versa but in the more involved sense that, if. one relation is considered to be the basis for form, then the other is interpretable in terms of contents. However, which, of the two types of relations is interpretable in one or the other way, that always remains a function of a given state of a system of subjectivity relative to its environment. Thus our answer will always be different. It will depend on whether we assume that the state of the system of subjectivity is cognitive or whether we note that it is volitive.

In order to obtain a general formula for the connection between cognition and volition we will have to ask a final question. It is: How could the distinction between. form and content be reflected in any sort of logical algorithm if the classic tradition of logic insists that in all logical relations that are used in abstract calculi the division between form and content is absolute? The answer is: we have to introduce an operator (not admissible in classic logic) which exchanges form and content. In order to do so we have to distinguish clearly between three basic concepts. We must not confuse

a relation
a relationship (the relator)
the relatum.

The relata are the entities which are connected by a relationship, the relator, and the total of a relationship and the relata forms a relation. The latter consequently includes both, a relator and the relata.

The relationship or the relator can, of course, assume many forms. It can be a negational operator. But the relationship can also be equivalential, conjunctional, disjunctional, transjunctional, or it can assume other logical forms. In arithmetic a plus sign or a symbol for subtraction e.g. are relators. Moreover we do not have to confine ourselves to formal languages – every living universal language contains a countless number of relationships.

These three distinctions between relation, relator, and relatum will enable us to answer the question how the distinction of form and content or, for that matter, between subjectivity and objectivity can be reflected in a specific sort of algorithm.

We assert: The distinction between form and content of form is algorithmetically equivalent to the distinction between the relationship (or the relator) on one hand and the individual relatum on the other. Nobody who ever used the therm 'subject' could have meant (although he will not have been aware of it) anything else but a relator and when he referred to 'objects' he talked wittingly or unwittingly about relata. However, when somebody used the term 'relation' (which means the relator *and* the relata) he referred unavoidably to a compound situation in which subject and object were inextricably fused. Incidentally, it should be added that the subjectivity involved in a complete relation is always the objective subject and not the subjective subject which generates, in the process of self-reference, an image of itself and in the process of hetero-reference an image of other egos, the Thous. It should now be clear why classic logic cannot handle the problem of subjectivity. A two-valued logic (as far as it is relational at all) deals only with relations, meaning: with a pre-established synthesis between relationship (relator) and relatum. And using such devices as the theory of types or meta-languages it can also use relations as relata. What these traditional

theories never deal with, however, is the theory of the relationship (relator) as related to the relatum. It is of utmost importance that this theory should not be confused with the description of the possible connection between a *relation* and a relatum. This can easily be taken care of by traditional logical devices.

We shall concentrate from now on the trans-classic relation between relator and a relatum. It will facilitate our understanding of this transclassic relation if we refer once more to the ontological problem which lies behind it. It is the peculiar nature of subjectivity in contraposition to objectivity. It is quite senseless – as Fichte has already pointed out in his criticism of Schelling – to speak of an object of an object. An object qua object has no objects, but a subject 'has' objects; which means: it constitutes itself only in its awareness of objectivity. And this objectivity will contain three subcategories of objects: 1) it will have an objective image of itself, 2) it will refer, by way of other images, to the physical things in its environment, and 3) its domain of objectivity will include – as pseudo-objects – other subjects, the Thous, and be aware of them as independent volitional centers, which are relatively objective to its own volitional activity.

This last observation makes us realize that our view of the world as our environment is rather one-sided, and that we may change places at any time with a given Thou which in its turn will act as a system of cognizance and demote us to the position of an observed system of volition within its own contexture of objectivity. In other words: the subjective Ego of cognizance forms with any other Ego it may confront an exchange relation. Or, to speak in the more abstract terms of an algorithm: what is a relationship (which means a relator) may now become a relatum and what was previously the relatum may now be elevated to the position of a relator. There is, however, a marked difference between the symmetrical exchange relation, as for instance implemented in the Table of Negation in two-valued logic, and the exchange of relator and relatum. In the classical exchange relation of symmetry only the two relata change their positions. Expressed formally:

$$R\ (x, y)$$

becomes

$$R\ (y, x)$$

This does not materially change anything. However, if we let the relator assume the place of a relaturn the exchange is not mutual. The relator may become a relatum, not in the relation for which it formerly established the relationship, but only relative to a relationship of higher order. And vice versa the relaturn may become a relator, not within the relation in which it has figured as a relational member or relatum but only relative to relata of lower order. If:

$$R_{i+1}(x_i, y_i)$$

is given and the relatum (x or y) becomes a relator, we obtain

$$R_i\ (x_{i-1}, y_{i-1})$$

where $R_i = x_i$ or y_i. But if the relator becomes a relatum, we obtain

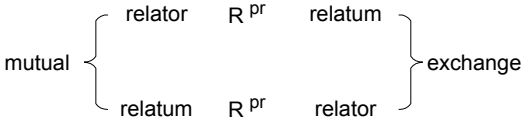
$$R_{i+2}(x_{i+1}, y_{i+1})$$

where $R_{i+1} = x_{i+1}$ or y_{i+1}. The subscript i signifies higher or lower logical orders.

We shall call this connection between relator and relatum the 'proemial' relationship, for it 'pre-faces' the symmetrical exchange relation and the ordered relation and forms, as we shall see, their common basis.[3] Neither exchange nor ordered relation would be conceivable to us unless our subjectivity could establish a relationship between a relator in general and an individual relatum. Thus the proemial relationship provides a deeper foundation of logic as an abstract potential from which the classic relations of symmetrical exchange and proportioned order emerge.

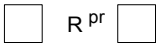
It does so, because the proemial relationship constitutes relation as such; it defines the difference between relation and unity – or, which is the same – between a distinction and what is distinguished, which is again the same as the difference between subject and object.

This author has, in former publications, introduced the distinction between value structures and the kenogrammatic structure of empty places which may or may not have changing value occupancies. The proemial relation belongs to the level of the kenogrammatic structure because it is a mere potential which will become an actual relation only as either symmetrical exchange relation or non-symmetrical ordered relation. It has one thing in common with the classic symmetrical exchange relation, namely, what is a relator may become a relatum and what was a relatum may become a relation. Or, to put it differently: what was a distinction may become something which is distinguished, and what has been distinguished may become a process of distinction. This applies to the mutual position of the subjective subject as the I and the objective subject as the Thou, insofar as what is now I may become a Thou, and what has been the Thou may become the I. And again in another version: what has been a volitive system may become the cognitive system and what has been the cognitive system may turn into a volitive system. Insofar the proemial relation displays the structural properties of exchange; but as we pointed out above, the exchange is not symmetrical. It does *not* have the form



The exchange which the proemial relation (R^{pr}) effects is one between higher and lower relational order. We can, as an example, consider an atom a relation between more elementary particles, the latter assuming then the part of the relata. But we can also say that the atom is a relatum in a more complex order which we call a molecule. Thus an atom is both, relative to the elementary particles it is a relator, but it can exchange this property with the one of a relatum if we consider it within the more comprehensive relationship of a molecule.

Thus the proemial relation represents a peculiar interlocking of exchange and order. If we write it down as a formal expression it should have the following form:



where the two empty squares represent kenograms which can either be filled in such a way that the value occupancy represents a symmetrical exchange relation or in a way that the relation assumes the character of an order.

It should be clear from what has been said that the proemial relationship crosses the distinction between form and matter, it relativizes their difference; what is matter (content) may become form, and what is form may be reduced to the status of mere "materiality". This reminds us of Aristotle's system of development which starts at its basis with the form and shapeless hyle which is as materiality a mere potential which becomes actual reality only by assuming a form. But this form again serves as a mere material potential for a higher form which in its turn assumes the role of the material substratum if it is topped by a new form still higher. And so it goes up the ladder in the exchange of matter and form till the apex of the pyramid is reached where the Aristotelian form of pure form appears. This is what later has been called the actus purus or the divinity.

However, the similarity to the Aristotelian concept of the relation of form and matter is superficial. In the metaphysics of Aristotle matter is clearly subordinate – and only subordinate – to form. Because, in order to emerge from mere potentiality into the actual, matter requires the assistance of form. But form, on the other hand, at the apex of the pyramid can support itself after the material component of reality has been fully absorbed into form. According to this scheme the opposite process – where all form melts into materiality – is not possible because form is the absolute superior to matter. In other words: the Aristotelian idea of development conforms only to one of our two figures_1 and _2 and therefore excludes what Warren McCulloch has called the "heterarchical" rule.

No wonder that for more than 2000 years a controversy raged whether cognition dominates the will or whether volition is the master of reason. The Aristotelian theory of development which should have answered this question remained ambiguous. It was never clear whether the so-called actus purus should be interpreted as reason or will. Only one thing was certain: if one accepted the Aristotelian theory of Development and its interpretation of the mutual relation of Form and Matter, then the relation of the two was definitely one of super- and sub-ordination. And if a philosopher chose to identify cognitive reason with form, then the theorem of the primordial primacy of Reason followed automatically. But if it was assumed that Form was the essence of volition, then the acclaim of primacy shifted from Reason to Will.

We know now enough to say that the Aristotelian viewpoint assuming a fixed hierarchical relation between Form and Matter, thus that Matter is always of lower ontological priority, is no longer acceptable. Especially not in cybernetics. What the proemial relation establishes is a heterarchical connection between Form and Matter and consequently between subject and object and therefore also between volition and cognition. Aristotle did claim that materiality – his hyle – is the sole potential which becomes actual and real only by assuming a form. But the proemial relation implies that we are equally entitled to say that Form is a mere potentiality which must be filled with content in order to become Reality.

Since this paper is devoted to the problem of the mutual relation between cognition and volition some remarks should be added as to how the proemial relationship unites these

two faculties and melts them together in a system of self-referential subjectivity. We stated that the proemial relationship presents itself as an interlocking mechanism of exchange and order. This gave us the opportunity to look at it in a double way. We can either say that proemiality is an exchange founded on order; but since the order is only constituted by the fact that the exchange either transports a relator (as relatum) to a context of higher logical complexities or demotes a relatum to a lower level, we can also define proemiality as an ordered relation on the base of an exchange. If we apply that to the relation which a system of subjectivity has with its environment we may say that cognition and volition are for a subject exchangeable attitudes to establish contact but also keep distance from the world into which it is born. But the exchange is not a direct one. If we switch in the summer from our snow skis to water skis and in the next winter back to snow skis, this is a direct exchange. But the switch in the proemial relationship always involves not two relata but four! Not only two subjective faculties, called cognition and volition, are exchanged, but the order of subject and object also suffers a reversal. What had to be interpreted as subjectivity in the cognitive attitude of the subject, namely the symmetry of position and negation, becomes, in the volitive faculty, a property of the objective world which offers a physical alternative for the will. And where, for the cognitive attitude, the whole Universe is content of the consciousness the volitional act is a content of this very same Universe. In other words: the symmetrical exchange relation between cognition and volition implies a reversal of the non-symmetrical order of subject and object. We have said above that the distinction between subjectivity and objectivity in an algorithm is reflected in the logical difference between relator and relatum. More than 2000 years of Aristotelian scientific tradition will make us inclined to say that the functional character of the relator always represents subjectivity and the argument character of the relatum refers to the object. We may still do so; but we should be aware that with such a semantic characterization we have wittingly or unwittingly implied that we interpret our algorithm as a calculus of cognition. The proemial relationship, on the other hand, permits us to reverse this interpretation and say that the relator stands for objectivity and the relatum should be treated as a subject. This is always the case if a cognitive system goes introspective or self-referential. If we prefer this second interpretation we have implicitly asserted that we consider our algorithm as a calculus of volitional processes. Incidentally, it is also possible to retreat from this hermeneutic attitude and to insist that only one is the case and the other is not. In other words: we do not deal with an ambivalent situation permitting different interpretations, but we are faced with a factual situation that is either correctly recognized or not. If we assume the epistemological attitude we have indirectly stated that our algorithm concerns only a subjectless Universe.

We are not going to analyze any further the difference between stating a fact and hermeneutically interpreting its significance. Instead, we shall devote the concluding part of this essay to a short demonstration of the heterarchical character of the proemial relation.

Part IV

Since the proemial relation concerns the link between relator and relatum it will effect exchange as well as order and make itself felt in the combination of all functors of traditional logic. We shall choose for our demonstration only two functors which are the

most familiar and at the same time the easiest to handle. Furthermore, we shall confine ourselves to an elementary triadic situation, although we stated in Part III that a full display of the character of proemiality requires four basic data: exchange, order, cognition and volition. We shall simplify the situation by reducing the basic factors to three which we shall name exchange, cognition and volition. We can easily do so, for the mutual relations will display some order anyhow. And the order we have in mind is, of course, heterarchy.

Since it is the only aim of this paper to lay open some structural relation in an extremely formal manner we let our three basic data be represented by three values (and it does not matter which value is assigned to which datum because this would again be a hermeneutical affair). For expressing the values in symbols we shall use the first three integers. To simplify matters further we shall use only two variables p and q. This will give us an underbalanced pattern of three-valued logic which is, of course, structurally incomplete, because, in order to demonstrate its full complexity, we would have to balance the system by adding a third variable. Our two-valued system of classic logic is always balanced by having two values as well as two variables, because no system of logic can be developed with less than two variables.

As a symbol of negation we shall use a capital N. And since our three values form, of course, mutual exchange relations the N will carry corresponding subscripts. For the exchange relation of the values 1 and 2 we shall write N_1 for the subsequent mutual exchange between 2 and 3 our negator will be written N_2; there is no need to introduce a special negator for a two-valued system carrying the values 1 and 3 as the total table of negations for a three-valued system shows.

Since a system of negation for any m-valued logic encompasses all possible permutations between the values, the table of negation for a three-valued structure has the following shape as shown in figure 6 below.

	N_1	N_2	$N_{2.1}$	$N_{1.2}$	$N_{1.2.1}$ oder $N_{2.1.2}$
1	2		2	3	3
2	1	3	3	1	
3		2	1	2	1

fig._6

We have separated the classic table of negation involving the values 1 and 2 and operated by the negator N_1 from the other parts of the table by a dotted rectangular line open to the left. And we have again separated the unnegated value sequence 1, 2, and 3 and its two negations by N_1 and N_2 from the second half of the table which contains what we shall call mediated negations, because the negation which establishes the specific configuration of any of the three vertical value sequences is always 'mediated' by the other negational operator. The negational operators of the second half of the table consequently show at least two and finally even three subscripts. They are not immediate negations of the original value sequence 1, 2, 3 but iterated negations. The last of the three mediated negations has been separated from the preceeding ones by a dashed fine because it shows peculiar properties not shared by its predecessors.

We shall begin our discussion of the mutual relations between hierarchy and heterarchy as we have promised with the two logical functors which are most familiar to logicians and the easiest to handle. These are conjunction and disjunction. Two-valued logic has not enough structure to distinguish between a hierarchical and a heterarchical aspect of conjunctivity and disjunctivity, but the distinction shows up clearly in a three-valued system. As long as only the two classic values are at our disposal we can only say that the conjunctive functor always prefers one value and the disjunctive one the opposite, provided, of course the two variables p and q offer different values.

In a three-valued system, however, there are six hierarchical patterns of preference possible. We can say that – if we declare value 1 to be positive and 2 and 3 being subsequent negations – conjunction will always use, in a three-valued structure, the highest value 3 and 2 only if 3 is not available, provided 3 will be the second choice. Disjunction, on the other hand, will always give preference to the lowest value 1 and only then to 2 if the second preference will be 1. This leads to the following hierarchical tables for conjunction (K) and disjunction (D).

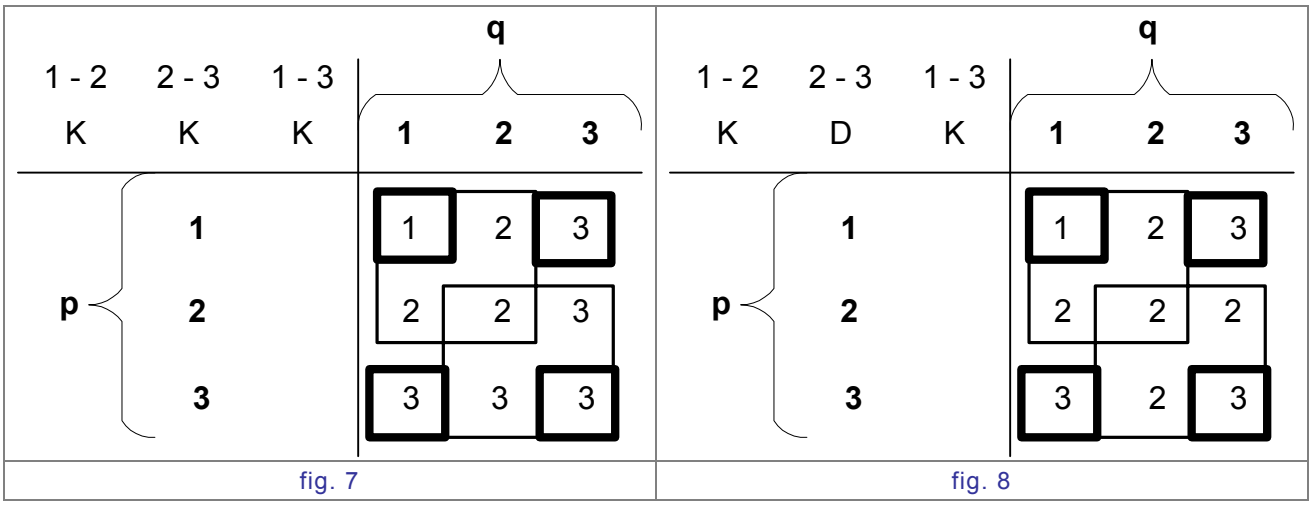


fig. 7

fig. 8

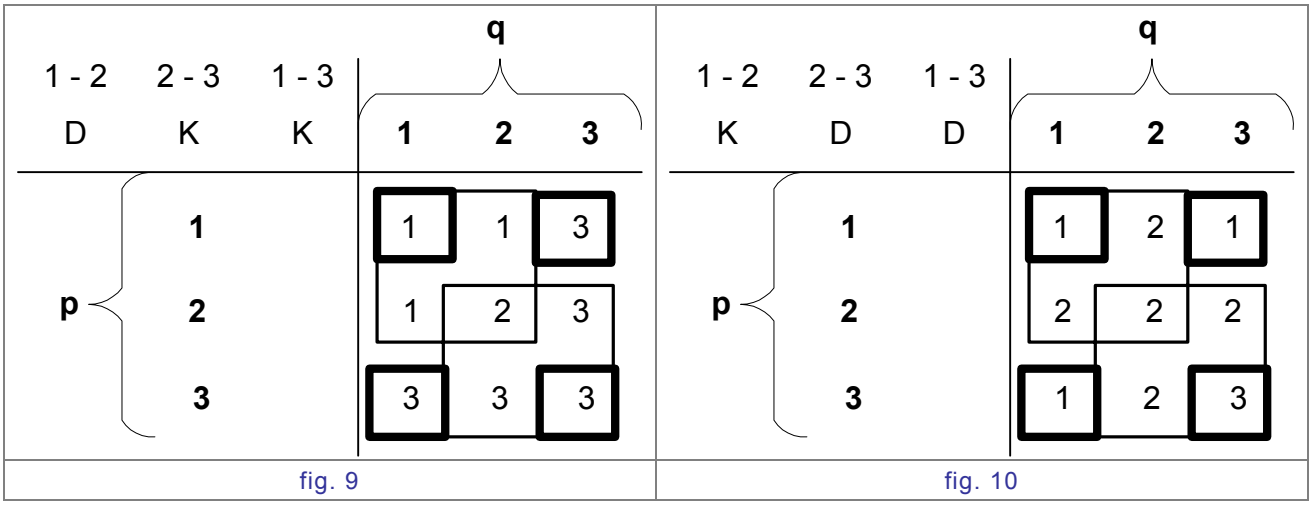


fig. 9

fig. 10

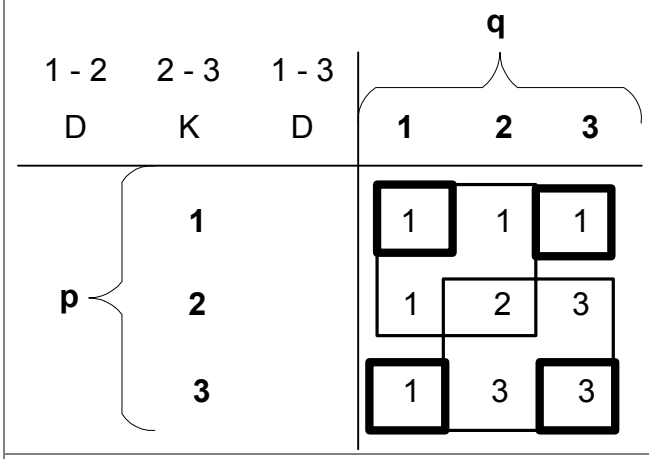


fig. 11

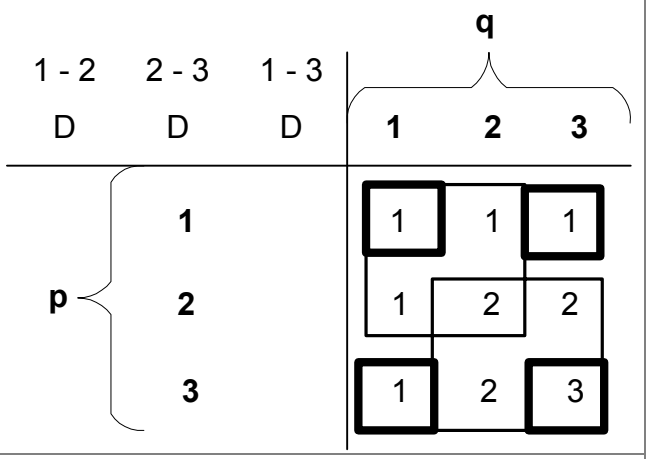


fig. 12

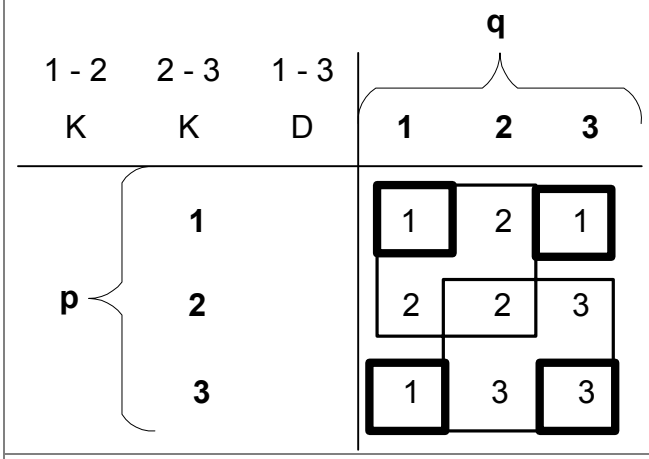


fig.13

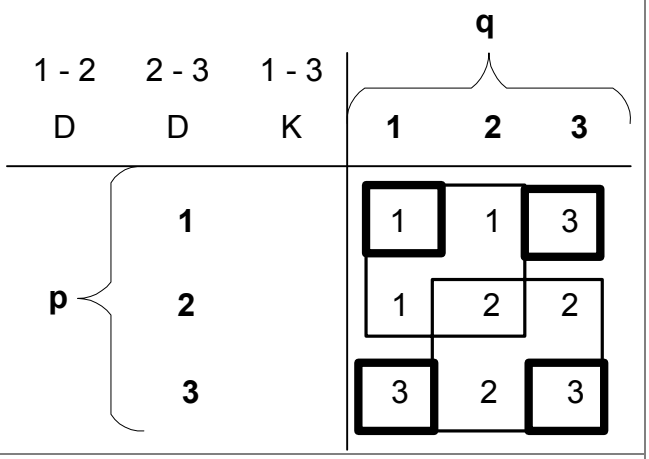


fig. 14

Figures_7, _8 and _9 belong to the conjunctive group. The following figures _10, _11 and _12 form the disjunctive group.

Our notation shows that we consider a three-valued system a place-value system of three two-valued 'logics' carrying either the values 1 and 2, 2 and 3 or 1 and 3. We have written the corresponding values to which conjunction (K) or disjunction (D) refer as superscripts on top of our functors. In each figure the interlocking of the three two-valued systems is shown by encasing the value choices of the two-valued subsystems in separate squares. For the systems of 1-2 and 2-3 only one square for each value interchange is necessary. These 2 squares, however, overlap in the central value choice of 2. For the mediating system 1-3 four small squares are necessary. Two of them are located in the larger squares because the mediating system shares with one of the other subsystems the value 1 and with the other the value 3. However, in two cases the value choice of the two-valued system 1-3 is independent. In this case we find two of the small squares outside of the larger squares, one in the top right comer and one in the bottom left comer. These six cases exhaust all hierarchical value choices for any combination of conjunction and disjunction. However, we notice that in the possible combinations of K's and D's two arrangements are still missing. They are KKD and DDK as shown in the. Figures_13 and _14.

In these two figures the two-valued subsystems operated by the single negators N_1 and N_2 are both either conjunctive or disjunctive, but the mediative alternative of the values 1 and 3 which is, according to our total table of negations, operated by a compound negator has always the opposite functor. Which means that, if the other two systems are conjunctive, then the mediating negator will be disjunctive and if they are disjunctive then mediation will assume a conjunctive function.

It is obvious that the value choice in these two functions will no longer be hierarchical because we have exhausted all hierarchical orders of preference. They will be heterarchical (or cyclic). In the case of KKD the order of preference is that 3 is preferred to 2 and 2 has preference over 1. the value 1, however, is in its turn preferred to 3 as figure_15 shows.

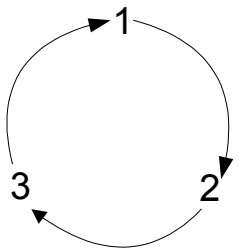


fig. 15

The arrows always point to the preferred number.

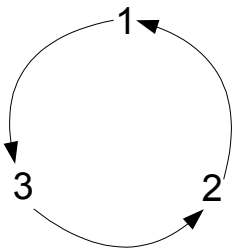


fig. 16

If we turn to the case of DDK (as shown in fig. 16) we notice that the cyclic order of preference is reversed. This time the value 1 has ascendancy over value 2. Value 2 in its turn is preferred to 3. But 3 takes precedence before 1.

It is interesting to know that in analogy to the deMorgan formulas which transform conjunction into disjunction and vice versa by first negating the variables and then negating either the conjunctive or disjunctive connection between p and q we can use exactly the same procedure of expressing KDK, DKK, KDD, DKD and DDD by applying our negation table of fig. 6. It turns out then that the two cyclic negations $N_{2.1...}$ and $N_{1.2...}$ do not yield the cyclic functions KKD and DDK. What we obtain instead is KDD and DKD, as the formulas below show:

$$p\ DKK\ q = N_1\ (\ N_1\ p\ KKK\ N_1\ q\ )$$

$$p\ KDK\ q = N_2\ (\ N_2\ p\ KKK\ N_2\ q\ )$$

$$p\ KDD\ q = N_{1.2}\ (\ N_{2.1}\ p\ KKK\ N_{2.1}\ q\ )$$

$$p\ DKD\ q = N_{2.1}\ (\ N_{1.2}\ p\ KKK\ N_{1.2}\ q\ )$$

$$p\ DDD\ q = N_{1.2.1}\ (\ N_{1.2.1}\ p\ KKK\ N_{1.2.1}\ q\ ) \quad \text{or}$$

$$= N_{2.1.2}\ (\ N_{2.1.2}\ p\ KKK\ N_{2.1.2}\ q\ )$$

A highly significant feature which should be noted but which will not be interpreted within the scope of this essay is that if we follow the order of the negational operators as indicated in figure_6 we do not obtain exactly the order of the conjunctive/disjunctive functors which they should have according to their logical strength.

The reason that negated conjunction does not produce the cyclic functors by simple application of the negational system of figure_6 is obvious. Since the variables are negated by one cyclic negator and the conjunctive relation itself by the other one, the heterarchical order of values cancels itself out and the result is again a hierarchical order. In order to obtain the two cyclic functors, KKD and DDK we have to use a more involved negational process as the two following symbolic expressions show:

$$p \ KKD \ q = N_{2.1} (N_{1.2} \, p \ KKK \ N_{1.2} \ q) \ KKK \ N_{1.2} (N_{2.1} \, p \ KKK \ N_{2.1} \, q)$$

and

$$p \ DDK \ q = N_{1} (N_{1} \, p \ KKK \ N_{1} \ q) \ DDD \ N_{2} (N_{2} \, p \ KKK \ N_{2} \, q)$$

These formulas demonstrate an interesting relation between hierarchy and heterarchy of values which is easily recognized if we reduce the two preceding formulas to the next two simplified expressions in which all symbols of negation have been omitted.

$$p \ KKD \ q = (p \ DKD \ q) \ KKK \ (p \ KDD \ q)$$

and

$$p \ DDK \ q = (p \ DKK \ q) \ DDD \ (p \ KDK \ q)$$

A heterarchical order of values is – as it is now easily to be seen – a peculiar connection between conjunction and disjunction which requires a minimum of three two-valued systems. The order of values is cyclic for the functor when and only when the two values which are not immediate successors are connected by a different functor than the other two subsystems use. If the subsystems with the values 1 and 2 and 2 and 3 are conjunctively connected the connection must be disjunctive for the values 1 and 3 and vice versa in order to obtain a heterarchical relation. This we know already. But what the preceding two formulas show is that purely hierarchical orders of values can be used to produce the cyclic arrangement. It is only necessary to connect, either by total conjunction the two functors which are partly disjunctive (but not cyclical) or by total disjunction the two noncyclic but only partly conjunctive functors.

It was necessary to develop the three-valued tables for the relation of conjunction and disjunction in a three-valued system with hierarchical as well as heterarchical value choice because conjunction and disjunction may serve us as basis for the derivation of the implicative functors. We could, of course, use conjunction and disjunction in order to interpret relations between cognition and volition from a viewpoint which we have not yet touched in our present paper. However, we will refrain from doing so because we will confine ourselves for the rest of our analysis to the elementary patterns of figures_1 and _2 where we combined a simple alternative of choice with a hierarchical connection between subject and object. If the subject operated cognitively we interpreted this as a domination of the object (environment) over the subject. And if the subject assumed a dominating role subjectivity had to express itself in a volitional attitude. This corresponds, in formal logic, to the function of implication – where, as we know from classic logic, the positive value implies only itself and the negative value implies itself as well as the positive value.

There is a very simple technical way to derive the value sequence of implication from conjunction and from disjunction. We shall start with a classic two valued conjunction

and disjunction as shown (as subsystems 1.2) in figures_7, _8, _10, _13 for conjunction and figures_9, _11, _12, _14 for disjunction.

1 - 2 K	q 1	q 2
p 1	1	2
p 2	2	2

fig. 17

1 - 2 D	q 1	q 2
p 1	1	1
p 2	1	2

fig. 18

1 - 2 C^K	q 1	q 2
p 1	1	2
p 2	1	1

fig. 19

1 - 2 C^D	q 1	q 2
p 1	1	1
p 2	1	1

In order to produce implication we always write down value 1 if the variables p and q offer the same value. And we do exactly the same when the value of the first variable (normally p) is higher than that of the second variable. If the value of the first variable is lower, then we retain for the implicative function the value that was shown by the conjunctive or disjunctive functor. This yields, in our case, for implication (C) figures_18 and _19.

Thus we may distinguish between conjunctive and disjunctive implication. To introduce this distinction into implication seems to be superfluous or even non-sensible in the case of classic logic since figure_19 shows nothing but positive values. This means that every datum of Reality implies not only itself but everything else. In other words: in the disjunctive implication of two-valued logic a totally subjectless Universe is implied which shows no gradient between objectivity and subjectivity, since the latter is non-existent.

On the other hand: if we proceed to a three-valued logic which corresponds to the minimal concept of a Universe which is a compound structure of objectivity and subjectivity we will not be able to derive even from total disjunction an implication which shows no gradient between position and negation. We shall only discover that there are many implications of different logical strength (where strength is understood in the sense in which Carnap used it in logic and von Foerster in biological computer theory). The strongest implication, will be the one derived from total conjunction (pKKKq) and the weakest will be the one dependent on the functor (pDDDq). The following figures_20 to _27 show the three-valued standard implications in the order of decreasing logical strength. We used the term ´standard implication´ because a three-valued systems has even more implications which can be derived from functors which are totally or partially transjunctive. However, within the scope of this essay we must ignore the problem of transjunctivity.

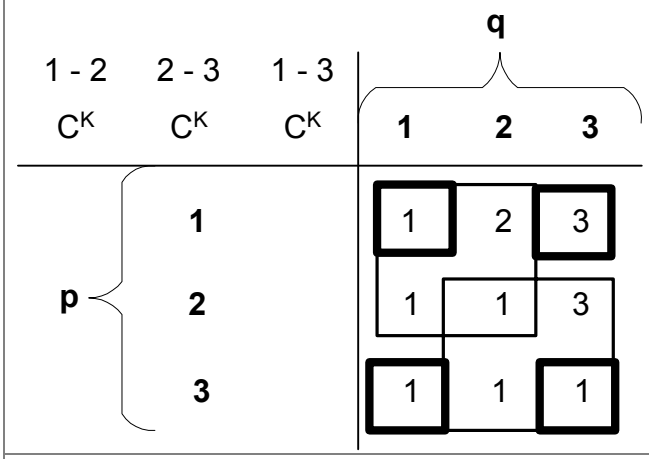


fig. 20

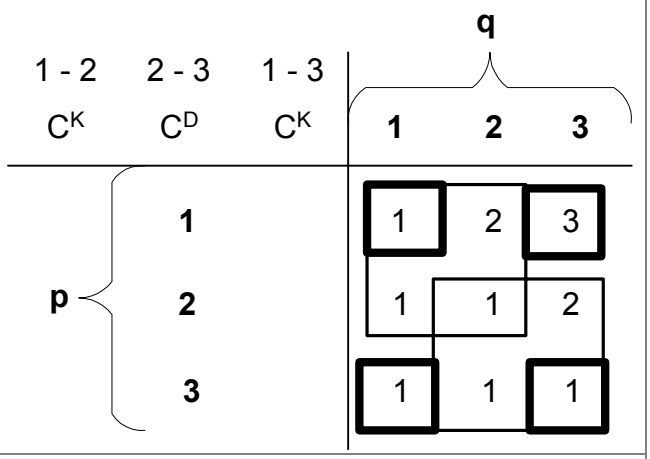


fig. 21

Figures_20, _21, _22, _23 show the conjunctive group of implications (C). If an implication derives its value sequence from conjunction it carries the index K. If the value choice is taken from disjunction the index is D, The following figures 24 to 27 show the value distribution in disjunctive implication starting with the other cyclic value order of figure 24.

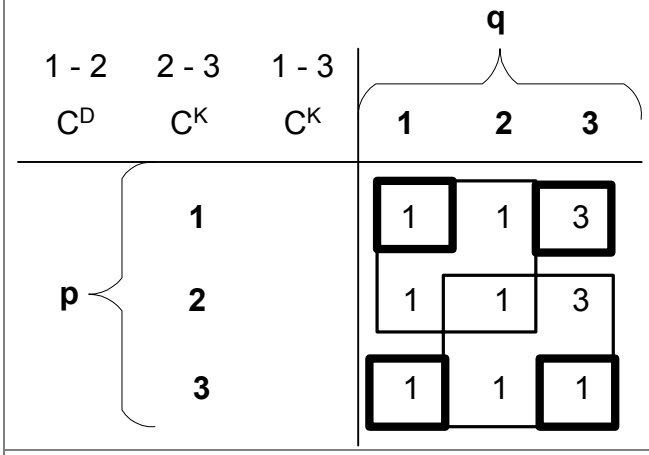


fig. 22

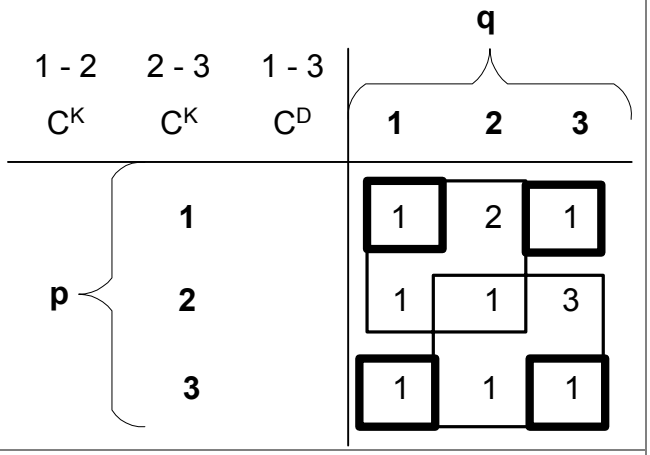


fig. 23

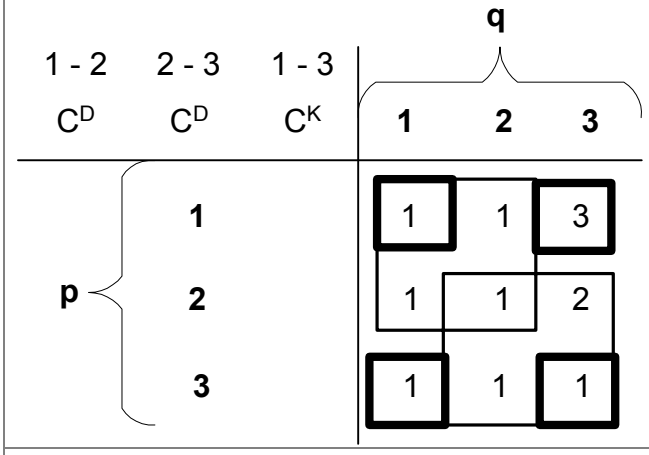


fig. 24

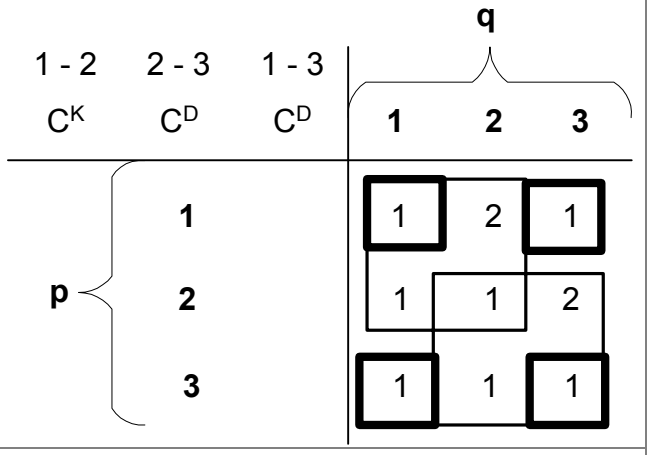


fig. 25

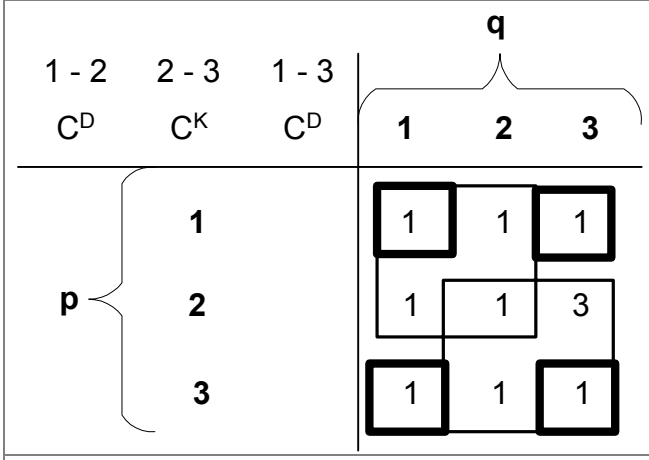


fig. 26

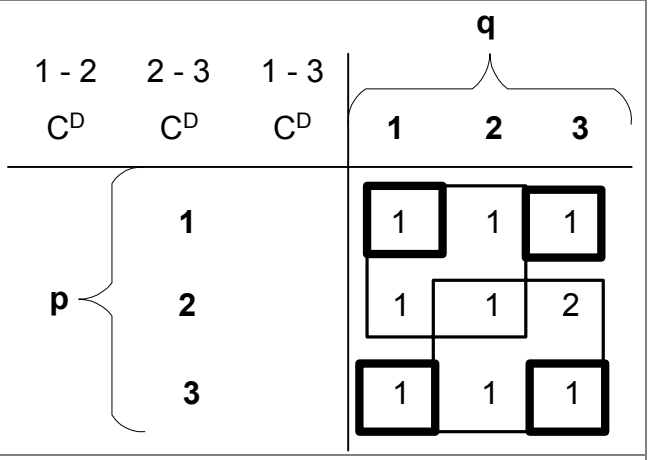


fig. 27

When we described the conjunctive and disjunctive functors, we separated them according to whether they showed hierarchical or heterarchical properties; but when we listed the corresponding implications in the figures_20 to _27 according to their logical strength we had to insert the two heterarchical implications between the first three which depended on those conjunctive-disjunctive functors which showed at least two subsystems being conjunctive (KKK, KDK and DKK) and those where at least two subsystems displayed disjunctive functors (KDD, DKD and DDD). When we inserted the heterarchical implications between these two groups we placed KKD ahead of DDK because KKD belongs, of course, to the group where conjunction prevails and DDK to the group where disjunction is dominant because, merely from the viewpoint of logical strength, we could as well have reversed their positions since both carry equal logical strength. This distinguishes them from the other six. In the hierarchical group every implication differs in logical strength from any other. The weakest, of course, is derived from total disjunction. But we notice that in contradistinction to two-valued logic the weakest is not one-valued but still carries, at least in one position, the lowest negative value – which means that even in the case of total disjunction a minimum gradient between objectivity and subjectivity is retained. It follows that a three-valued formal structure never refers to a totally subjectless Universe although it must be conceded that the amount of subjectivity which comes into play in a three-valued structure is minimal.

When we introduced figures_1 and _2 with the arrow in one case pointing from the environment into subjectivity and in the other case the arrow aiming from the subject towards the environment we explained that this meant that between subject and object there is always a relation of dominance or a gradient of strength which either decreases from the object towards the subject – as shown in figure_1 – and signifies cognitive attitude on the side of the subject or which decreases from the subject towards the object. And this signifies a volitive attitude of the subject.

The fact that this gradient, when expressed in formal logical terms, boils down to implication and the other fact that we are dealing with implications of different logical strength indicates, ontologically speaking, that the dominance of the object over the cognitive subject and vice versa the dominance of the volitive subject over its environment will be capable of various degrees of strength. We pointed out above that

in empirical reality we will never encounter a purely cognitive or a purely volitive attitude of the subject. Even the most contemplative cognition, in order to exist at all, has to be supported by a modicum of volition. And no volition can come into action, unless it has been triggered by at least a wisp of an image conceived by cognition.

The more, of course, the influence of volition on cognition grows the weaker becomes the dominance of the environment over the subject. And the more "the native hue of resolution is sicklied o'er with the pale cast of thought" the weaker it becomes and the more the environment asserts itself, till the Will, totally hung up in image reflection, is incapable of decision. Thus the circle closes.

It is well known in logic that two inverse implicative gradients added together conjunctively form an equivalence. This is expressed in classic logic by

$$(p \; C^K \; q) \; K \; (q \; C^K \; p) = (p \; E \; q)$$

The above formula expresses the conventional viewpoint. The equivalence (E) is obtained by reversing the role of p and q as implicator and implicand. But we would achieve the same result if we refrained from reversing the positions of p and q and insisted rather unconventionally that a second type of implication is available to us where the negative value implies only itself and the positive itself as well as the negative. Both implications conjunctively added together would again yield equivalence. The second interpretation is not acceptable in the classic tradition of logic because it runs counter to its epistemological significance where subject and object cannot form a symmetrical exchange relation since classic logic cannot use its negations to describe a system of subjectivity. On account of its isomorphic character negations as well as assertions describe the very same subjectless Universe. But the above considerations throw a significant light on the mutual role of variable and value.

This role is different in many-valued systems and this is the point where the proemial relationship comes into play. Because the distinction between logical value and variable refers in a different form again to the relation between relator and relatum. Equivalence, of course, is a symmetrical exchange and implication an ordered relation – and let us repeat that the proemial relation is a connection between the two which can be interpreted (hermeneutically) as an exchange based on increasing or decreasing order or a fixed order founded on symmetrical exchange. It goes without saying that if we distinguish implicative orders of various logical strength we have automatically at our disposal also a corresponding number of distinctive equivalences with different value characteristics. A calculus of proemial relations which we have described in this paper only in the most abstract terms would, in its concrete development, no longer refer to the vague term 'symmetrical exchange' but would have to state on which of the many possible equivalences the exchange is based and if the proemial relation referred to higher or lower order, it would have to state which implicative strength the order has.

To conclude this analysis let us sum up the direct and the implied results in the following way: We are, for the time being, incapable of designing cybernetic machines which display approximately the traits of subjectivity which the brain – supported by the other parts of the body – produces. when brought in contact with its environment. Even a machine like the Iliac_IV and other equally complicated or even more advanced designs which may be in the making imitate only the mechanisms of a subjectless

Universe. For the time being more is not possible; for we do not yet possess a theory of subjectivity translatable into a mathematical algorithm. Moreover, this theory of subjectivity can as yet not be developed because we are still under. the influence of the age-old controversy regarding the primacy of Reason or Will, resp. of cognition or volition. We know that any system of subjectivity is set in motion by the two interacting programs of cognition and volition. But using exclusively Aristotelian logic in our thinking we cannot rid our-selves of the prejudice that either Reason must be the ultimate guide for the blindness of an otherwise helpless Will or that the power of Will must absolutely dominate the image-making of cognition. We are not yet sufficiently familiar with the insight that the connection between cognition and volition is in its inner core heterarchical and governed by the proemial relation.

One final remark. When in the past philosophy has asked itself whether the very core of the soul is cognition and volition only its subordinate attribute, or whether subjectivity is basically volition with some secondary cognitive capacities, our own analysis suggests that the whole controversy of the primacy of Reason or Will has its origin in an illegitimate metaphysical assumption. Our classic tradition believed that not only bona fide objects but subjects are also positively identifiable. (A significant expression of it is Kant's term "Ich an sich".) The trans-classical logic denies the validity of this assumption. It stipulates that subjects are only negatively identifiable. We shall explain what we mean by seeking an analogy in modem music. The English composer Edward Elgar once wrote a piece which he called "Enigma Variations". In this composition the variations of a theme are given *but the theme itself is not stated.* In our terminology: The theme is not positively identifiable only negatively. Likewise, our theme "subjectivity" is not stated if we speak of the I, the Thou, of cognition or volition. All these terms are only variations of a hidden theme which can never be directly identified.

The Greek classic term of truth is Aletheia which means "that which is not concealed". To seek out that which is not concealed is the self-confessed aim of our classic scientific tradition. Cybernetics, however, will only attain its true stature if it recognizes itself as the science which reaches out for that which is hidden.

Notes and References

1. The validity of this division is implied in platonic idealism, and it is well compatible with naive ("vulgar") materialism as well. It is incompatible with dialectic materialism.

2. W. St. McCulloch: "Toward Some Circuitry of Ethical Robots or an Observational Science of the Genesis of Social Evolution in the Mind-Like Behavior of Artifacts", Acta Biotheoretica, Vol. XI, p. 147-156 (1956).

3. The proemial relationship (Greek: prooimion = prelude) is not an original idea of this author. It is implicit in Hegel's dialectic logic. Moreover, it has been correctly described in a long forgotten book by the theologian Karl Heim, *Das Weltbild der Zukunft,* Berlin 1904. Heim calls it: das Grundverhältnis. However, he makes a peculiar use of it. Since he is incapable of conceiving trans-classic logic, he uses this relationship in an attempt to have philosophy totally replaced by theology.

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LIFE AS POLY-CONTEXTURALITY*)

by Gotthard Günther

Kein Lebendiges ist ein Eins,
Immer ist's ein Vieles. (Goethe)

Part I : The Concept of Contexture

A great epoch of scientific tradition is about to end. It has lasted almost two-and-a-half millennia and philosophers and scientists begin to call it the classical period of science. However, there is not yet a clear conception of what basically characterizes the past scientific tradition and what distinguishes it from the era we are about to enter and which might rightly be called the age of trans-classical science. We shall start our reflections with a short analysis of the fundamental difference between the two. It is possible to trace the distinction between the classical and the trans-classical back to deeply hidden metaphysical assumptions about the nature of this Universe.

Everybody knows that the Greeks were the creators of the classic concept of science, and that this concept was first clearly formulated by Aristotle. The dominating intent of the philosophy of Aristotle is, as he himself insisted, purely methodological. He starts from the sharp Platonic distinction between Being and Thought or between object and subject, and poses the question: How can Thought ever know Being in a rigorous and communicable way? The method is – according to the Aristotelian logic – found to be in the deduction of the particular from the general. The general, however, is something which bridges the cleft between the objectivity of Being and the subjectivity of Thought. Despite their infinite variety the particular things that exist in this Universe have something in common that links them ontologically together and that is their ultimate essence: Being, manifesting itself as objective existence. The realness of the objects is always the same at the bottom, although it appears in infinitely differentiated properties. In short: Being is an undifferentiated all-pervading universality and the many things and appearances in this world are only the more or less particular manifestations of an underlying general substance or essence, which is the same in everything that exists in this world. If we are looking for distinctions we have to move into the realm of the particular. Being-in-general shows no distinctions.

On the other hand, as Aristotle points out, when we think we also try to deal with the relation between the general and the particular by either deducing the particular from the general or by inductively ascending from the particular, to the general. Thus Greek philosophy discovered a common link between subjective Thought and objective Reality. It is the general or – as it is better called in its ontological aspect – the universal. The general is, – qua Being, the ultimate substratum of Reality on which

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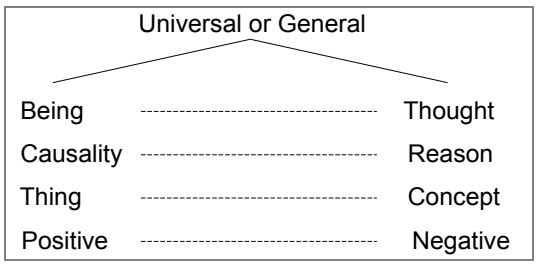
*) erstmals veröffentlicht in: H. Fahrenbach (Hrsg.), Wirklichkeit und Reflexion, Festschrift für Walter Schulz, Pfullingen 1973, 187-210
Abdruck in: Gotthard Günther, "Beiträge zur Grundlegung einer operationsfähigen Dialektik", Band 2, Meiner Verlag, Hamburg, 1979, p.283-306

everything rests, but at the same time it is the supreme Idea from which all particular thoughts derive.

It follows that we are in possession of something which Leibniz much later called pre-stabilized harmony between our thoughts and Reality. On the one side the general qua Being is the cause of the things and events in this physical world; on the other side the general is the reason from which our ideas and concepts logically follow. The Table I below illustrates this dualism which emerges from the peculiar ambiguity of the general:

Table I



It follows, according to Aristotle, that a logical necessity as conceived in the mind of the scientist is the exact image of the objective connection which links Being in general to the particular things in this world and their properties. In other words: Thinking faultlessly will always describe objective Reality in an adequate way. This implies that by following the laws of reason we may accurately postulate the existence of things in this world before we have empirically discovered them. An example in modem physics is the postulation of the existence of elementary particles long before the experimental means are available to demonstrate their reality in a physics lab.

In view of its amazing success in the history of western science, we do not see the slightest reason to quarrel with the Aristotelian theory of epistemology, at least as far as it goes. But this theory – solid as it is within in its own confines – has certain limitations. It has happened again and again in the development of classical science that the latter was confronted with certain phenomena occurring in this world where the answer of the investigating thinker always had to bet that the phenomenon in question could not be explained because of its irrational character. Thus the question arose whether the world we live in is perhaps composed of two antipodal components, one being rational and accurately describable and one irrational and not conceivable by rigorous logical means. It is the characteristic feature of all classic science that the answer to the above question has been emphatically affirmative. Moreover, the source of this irrationality was identified as the subject of cognizance itself. It was pointed out – with some justification that objectivity could not possibly be the source of the irrational; which left only the subject. And since the Aristotelian epistemology required a clear cut distinction within subjectivity between the subject as the carrier or producer of thoughts and the thoughts themselves, it was reasoned that the subject of cognizance could have rational thoughts without being a rational entity itself. To seek the source of irrationality on the side of the subject was quite plausible, because subjects can err and sin but nobody in his right mind would insist that mere objects are capable of sin or error. They just are. In the course of classic tradition the two terms "objective" and "rational" have become practically synonymous.

It is the mark of distinction between the period of classic science and present attempts to establish a concept of trans-classic science that we are nowadays forced to question the theorem of the irrational character of the subject of cognizance. Since Kant´s *Critique of Pure Reason* we know, at least logically, that certain features of subjectivity

can be interpreted in rational terms. And more recently, especially since the advent of cybernetics, it has been demonstrated that certain data that the classic tradition judged to be "spiritual" or "transcendental" can be unmasked as mechanisms. In other words: they are capable of objectivation and technical replication … so they cannot have an irrational root.

However, since we insist that the Aristotelian epistemology is valid as far as it goes, the only way open to us is to ask ourselves whether this basis of knowledge might not be broadened. In order to do so let us go back to the original metaphysical assumption from which Aristotle starts: Everything there is in the Universe shares in the general category of Being. And Being is identically the same in all appearances and varieties of existence. As much as any two things might differ in the predicates or properties that belong to them, they are identical qua Being. Being is the underlying substratum which carries everything and which pervades all there is in exactly the same way. This means: Being per se is – as noted above – in itself totally undifferentiated. It is "symmetrical" having no different properties in different parts of the Universe. The only distinction that can be attributed to it is that it is distinguishable from Nihility or Nothingness. Nothingness and Being are related to each other in such a way that their mutual ontological position is defined by the logical principle of the Tertium Non Datur (TND). Something is or it is not; that is all there is to it in ontology.

It is obvious that the alternative between Being and Nothingness is the absolute widest that our thinking may conceive and we shall call, from now on, a domain which is characterized by an absolutely uniform background and whose limits are determined by an absolutely generalized TND an ontological contexture or contexturality. The role that the TND plays with regard to the concept of a contexture indicates that the structure of such a domain can be exhaustively described by a two-valued logic. At this junction it is important to remember that the TND which encompasses the domain must be the most general that is conceivable because a two-valued logic implies an infinity of TND´s involving partial negations. If we e.g. pose the alternative "the defendant is guilty or not guilty", then we encounter also a TND of sorts. But the range of terms is rather limited because it extends only to juridical concepts, and it should be pointed out that such a TND does not constitute a genuine contexturality. We make a sharp distinction between the familiar term "context" and "contexture". If we speak in every day language of context we do not imply a universal TND the generality of which cannot be surpassed but we make this very implication when we speak of contexture or contexturality.

We are now ready to see the deep ontological assumption which lies behind the epistemology of Aristotle. It can be formulated as follows: the Universe is, logically speaking, "mono-contextural". Everything there is belongs to the universal contexture of objective Being. And what does not belong to it is just Nothingness.

From all this follows that every logical operation we can perform is confined to the contexturality in which it originates. It is trivial to add that no logical operation can start in Nothingness or continue there. But also, if we count numbers this process of counting, i.e., the sequence of numbers, is *confined to the contexturality in which it originates*. You cannot cross the borderline between Being and Nothingness and still continue your process of counting.

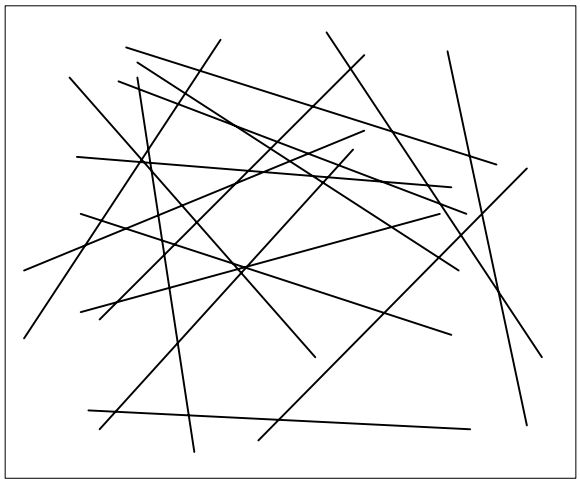
Such arguments are obvious. However, what is by no means self-evident is that we have to consider Nihility or Nothingness also as an "ontological" contexture. The difficulty is

that, if we insist on describing Nothingness as a contexture, we have to borrow our terms from Being, and doing so we discover we have only repeated our description of the contexturality of Being [1]. Nevertheless, the domain of Nothingness has proved extremely useful in the history of human thought. Whenever it was assumed that Reality harbored a rational as well as an irrational component the contexture of Nothingness served as the ontological location for everything that did not seem to be rationally conceivable. It also served as the ontological locus into which the observer of the world could be placed because it became very soon evident in the history of logic and of epistemology that the classic pattern of thinking with its concomitant mono-contextural ontology offered no place for the observer of the world or the thinking subject because it would have been absurd to assume that the subject of *cognizing* belonged in the contexture of that which was *cognized*. On the other hand, since that which was cognizable on principle constituted the possible range of world experience, there was no place for the subject inside the world. Thus human thought unavoidably projected a transcendent domain beyond all Being, and Nihility served as a very convenient vehicle for such projection. The most outstanding historical example of such a projection is the "negative theology" of Dionysius Areopagita.

The ontological domain of Being – i.e. our first contexturality – had its range of objects generated by the TND (in the field of partial negations) and if there ever existed any agreement in the history of logic, then it was this: that such a logical principle could not generate the ontological conditions for the existence of a thinking subject. The relation of the cognizing subject to its range of objects is always one of discontexturality [2]. Of course, this argument should also have been valid for the contexturality of Nothingness, but by transposing this contexture into a supernatural Beyond, the mysterious Nihility was exempted from such rigorous demands.

The first thinkers who broke consistently with the Aristotelian assumption of the mono-contexturality of this world were the transcendental-speculative idealists Kant, Fichte, Hegel and Schelling. It was especially Hegel who pointed out (although in a different terminology) that Reality must have a poly-contextural structure; and that it is impossible to bring two different contexturalities into an immediate confrontation. This lies behind the provoking statement in the first part of his "Science of Logic" (Wissenschaft der Logik) that Being is Nothingness and Nothingness is Being, and that they cannot be distinguished in their immediacy (Unmittelbarkeit) [3]. He then continued to demonstrate that there is one basic category which cannot be harbored either in the contexture of Being (which represents a static IS) or in the contexture of Nothingness. This is the category of Process or Becoming (Werden). By showing how Becoming has a component of Being as well as Nihility, he unwittingly laid ground to a theory of "poly-contexturality". Because, if we want to establish such a theory, we should not assume that all contexturalities can be linked together in the way a geographical map shows one country bordering on the next in a two-dimensional order. If the contexturality of Becoming overlaps, so to speak, the contexture of Being as well as of Nothingness, and the contexture of Becoming in its turn may be overlapped by a fourth contexture which extends beyond the confines of the first three, we will obtain a multi-leveled structure of extreme logical complexity.

Table II



Hegel´s logic further shows that if a plurality of contextures is introduced one cannot stop with three. In fact, one has to postulate a potential infinity of them. If one believes Hegel and there are most convincing arguments that one should – then *each world datum in the contexturality* of *Being should be considered an intersection* of *an unlimited number of contextures*. Table II with its seeming chaos of straight lines crossing each other at all possible angles may illustrate what is meant. Each contexture is logically finite insofar as its structure is confined to two values. But their respective ranges are infinite because one can generate, within the respective domain, a potential infinity of natural numbers. We have indicated the logical finiteness of the different contextures by having them represented by lines no longer than 2 inches.

In Table II our contextures are arbitrarily chosen and what they represent seems to be a rather chaotic jungle. However, we insist that there is no such thing as chaos in Reality. In fact, we may say that Reality and Order are synonymous terms. If something is, it must have order and if it appears as chaos it only means that we have not yet found the code which unravels the seeming chaos and shows us the hidden order in the imbroglio.

There is no doubt that this Universe we live in displays an enormous amount of contextures in a bewildering arrangement. Since we have defined a contexture, by reference to the TND, as a domain the boundaries of which cannot be crossed by processes taking place within the range of the domain, we are forced to assume that all psychic spaces of living organisms – constitute closed contextures. It is self-evident that the process of thinking taking place within one person cannot be continued into the psychic space of a second person. My thoughts, as mental events, are only mine and nobody else´s. A second person may produce the very same thoughts; but they are his and can never be mine.

The concept of contexturality illustrates the age-old logical distinction between identity and sameness. If I count 1, 2, 3, 4, … and so does my neighbor, then the numbers we both count are the same. However, insofar as these numbers have their existence only in the counting process, they are not identical because the two counting procedures can be clearly distinguished as having different origins in two separate organic systems. In other words: in the situation described above the sequence 1, 2, 3, 4, … turns up in two separate contextures. And no matter how far I count there is no number high enough to permit me to cross over to the psychic space of my neighbor.

But what we say about ourselves and our neighbors is equally valid for every animal as far as it has a consciousness, and this alone shows that the number of closed contexturalities which crisscross this Universe is enormous.

On the other hand, if we speak about the Universe as a whole, the very term uni-verse suggest that all contexturalities somehow form a unit, the unit of contextural existence

and co-existence. We shall call such a unit a compound-contexturality. In other words: the confusing lines of Table II must form, in their relations to each other, an order which constitutes a unity. Part II of our analysis shall show how such an order or unity can be detected.

Part II : Contexture and Proto-Structure

We have insisted that a contexturality is a logical domain of a strictly two-valued structure and its range is determined by using the TND as an operator such that the generality of the alternative which the TND produces cannot be surpassed. In other words: if we consider the Universe as a compound-contexture it must be composed of an innumerable number of two-valued structural regions which partly parallel each other or partly penetrate each other since, as we pointed out, each observable entity in this Universe must be considered an intersection of an unlimited number of two-valued contextures. This suggests the following idea: If we consider such a point of intersection as belonging only to one contexture, the point can only be occupied (consecutively) by two values. If we consider it as belonging to two contextures, the point will still only be able to be occupied by two values but they may now belong to two different contextures. This means: one value may belong to one and the other value to the other contexture … provided the contextures intersect at the place which is occupied by the value.

In Part I we introduced the distinction between sameness and identity. The two-valuedness in each contexture is the same as the two-valuedness in any other contexture. But this does not mean that – let us say – the positive value in contexture A is *identical* with the positive value in contexture B. But as the identity of the "same" value changes with reference to different contextures, we may – although we insist that our Universe displays in each contexture a strictly two-valued structure – introduce a system of many-valuedness with regard to the identity problem. Such a system of many-valuedness will *not* constitute a many-valued logic which we may use as a vehicle for our thinking. It will *not* describe the Laws of Thought as produced by a human consciousness. It cannot be done because, according to what we have previously said, the psychic space in which thought processes evolve constitutes a closed contexturality and is, as such, strictly two-valued. But the projected system of many-valuedness will form what we shall call an ontological grid which determines the relations of the various contextures to each other.

It will be our next task to construct the most elementary form of such a grid. We must start, of course, with a one-valued system and there is little to say about it because it can only be represented by a single symbol and no operator is as yet available to manipulate it. Moreover, if by some miraculous method we could manipulate it, this would entail transforming our symbol into a different one but since no second symbol is available the only manipulation which might be conceivable would make our symbol disappear. In order to obtain a system capable of positive manipulation, we must turn to a two-valued system, which – trivial to say – requires two values *and* two places to put them in. This leads to $2^2 = 4$ possible combinations of the available values, as shown below:

T F T F
T F F T

where T means, in classic logic, "true" and F "false." However, since we insist on distinguishing places from values which can be put into places we have a means to tell bare structure from the value configurations which may occupy it. We shall use for empty place structures the small letters of the alphabet and it is obvious that the letter sequence $\begin{matrix} a \\ a \end{matrix}$ represents $\begin{matrix} T \\ T \end{matrix}$ as well as $\begin{matrix} F \\ F \end{matrix}$ and that $\begin{matrix} a \\ b \end{matrix}$ stands for $\begin{matrix} T \\ F \end{matrix}$ and also for $\begin{matrix} F \\ T \end{matrix}$. If we proceed to a three-valued-system – which means, of course, adding one more value and one additional place – we obtain $3^3 = 27$ value configurations which shall be reduced in the same manner. Thus we obtain the following place structure:

a a a b a
a a b a b
a b a a c

So far, so good. But since we are intent on reducing our structures to the barest possible minimum, we shall now stipulate – a stipulation not yet necessary in the case of two-valued logic – that the position of a place symbol in a given symbol sequence shall be irrelevant. This enables us to reduce the 5 vertical sequences above to 3. So we get the following result:

a a a
a a b
a b c

We shall, for convenience´s sake, always start with the letter a on top and introduce b only after our store of a´s is exhausted. And c will follow when there are no more b´s available to put them above it, and so on.

Our next step leads us to a system with four values and four places. Here the number of comparable value configurations increases to $4^4 = 256$. In order to reduce this amount to a size comparable to the previous place structures, we add another stipulaton which was necessary neither in the case of the two nor the three-valued system. We shall make the condition that, in addition to the former restrictions, only the symbol for the first place (a) may be repeated in a single vertical column. This leads to the following drastic reduction. First step:

a a a a a a a a a a a a a a a a
a a a a a b b b b b b b b b b b
a a b b b a a a b b b c c c c c
a b a b c a b c a b c a b c d

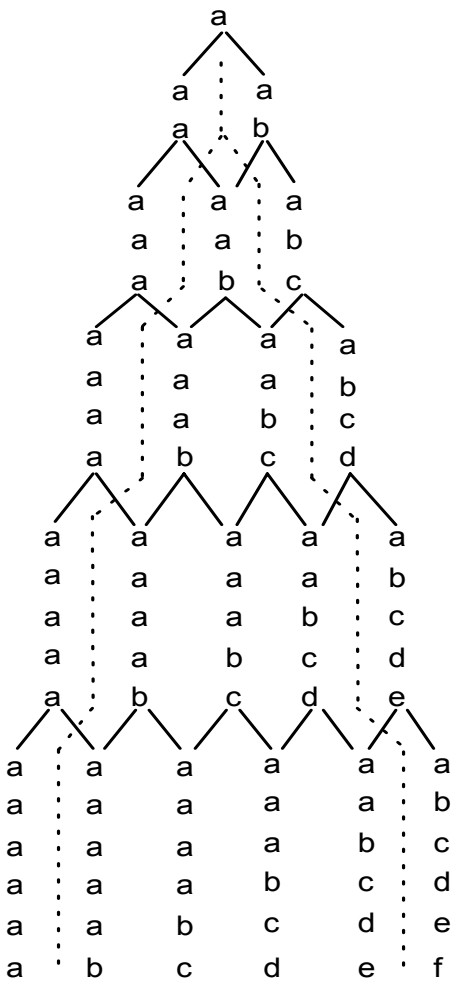
If we then ignore that the position of our letters is relevant, we obtain (as a second step) the further reduction to

a a a a a
a a a a b
a a b b c
a b b c d

However, since we will permit only one place symbol to be iterated, we have to eliminate the central vertical column and we obtain as the final result

a a a a
a a a b
a a b c
a b c d

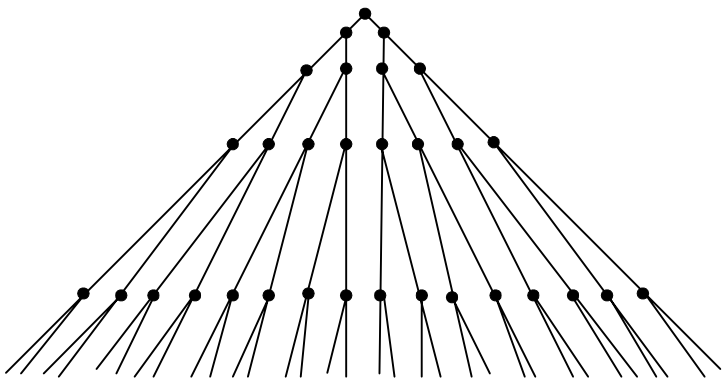
Table III



If we proceed to a five-value system no further reductional stipulations are necessary to obtain the bare minimum structure; and this goes too for all further increases in values and places. Thus we obtain a kind of pyramid with a single place on top and an ever broadening base at the bottom. For every value added the base increases its width by one vertical column as shown in Table III.

This table displays the most elementary structural configuration for places corresponding up to 6 values. We have connected by continuous lines the vertical columns of ever increasing length according to a rule which shall be explained further on. We have also drawn dotted lines which separate the letter sequences at the extreme left and the extreme right from what there is between them. These value sequences, where on the left side the place symbol never changes and on the right side no letter is ever repeated in a given vertical sequence, have logical characteristics which set the commonly apart from all the other sequences. The letter arrangement in Table III was, in former publications of the author, called "proto-structure" and we shall use this term from now on.

Table IV



The proto-structure gives the appearance of rather trivial structural characteristics. But it contains, as we shall soon see, at least one essential feature which is anything but trivial. We shall describe it in contrast to another pyramid which stems from the days of Plato and which describes the relation between the genus proximum and the differentiae specificae in a classic two-valued logic. This pyramid starts at the top with the most general term (the Platonic Idea) and

reaches down from there to the more and more particular and would have, at the bottom, the set of all irreducible individuals – a logical goal which, of course, can never be obtained since the pyramid is as bottomless as the one of proto-structure.

Table IV shows this pyramid and we see at once that it illustrates a famous metaphysical principle as pronounced in antiquity. It is contained in the terse Platonic statement ὁδὸς ἄνω κάτω μία (the way up and down is one). If we want to trace the track from one single point below to the top of the Platonic pyramid, we notice that there is one and only one way to do it. And if we want to return from the top to the very same particular point, there is no other road but to retrace our original steps.

What this pyramid depicts is the structural pattern of an absolute hierarchy where all elements are linked by a common measure. This assumption that the universal dominantes the particular and that the relation between the two is totally non-ambiguous has governed all ontological reflections as well as specific mathematical and logical endeavours for more than two millennia. We may add now, after what was said in Part I, that this order will always be valid and unimpeachable, provided we restrict ourselves to a closed contexturality.

If we now compare the Platonic pyramid with the pyramid of proto-structure in Table III, we are in for a considerable surprise. We shall notice that the ancient metaphysical thesis, that the way up and the way down are identical, holds only for the symbol sequences on the extreme left and the extreme right, located outside the dotted lines. In both of these cases there is only one way to go from the bottom to the top and the very same way to descend from the top to the bottom. For all the other sequences, however, this principle is invalid. We shall illustrate this with the way the sequence a a b issues from the sequences a a and a b. We have an equal right to say that our three-place sequence is derived from a a by adding b to it; but we might as well say that a a b emerges from a b by repeating the a. This means that for all the symbol sequences inside the dotted lines there are various ways from the bottom to the top and vice versa. And going down to the very same place we have the choice of taking the same way we came up but we might as well, within the given limits of the structure, choose a different route. This is the meaning of the connecting lines between the letter columns. They indicate the possible choices for ascending or descending between the top and base of the pyramid.

This possibility of choice is very significant because it shows that we may also use the pyramid of proto-structure as a Platonic pyramid. It goes without saying that by doing so we forfeit theoretical possibilities which might be otherwise available.

Here we come to an important point in the theory of trans-classic contextures. Since the advent of the so-called many-valued logics, conservative logicians have insisted again and again that there is no need to go beyond two-valued logic and that every aspect of the Universe wherever we look displays a two-valued structure [5]. This is perfectly true and we are the last to deny it. But the argument misses the point. Wherever we extricate any two data from this world, we will find that they share in a common contexture and that their relations can be described by a two-valued logic. This test will never fail us. But since we pointed out that every ontological datum of the world must be considered an intersection of an infinite number of contextures, the fact that – any two data we choose to describe in their common two-valued relations belong to one contexture does not exclude that the very same data may also – apart from the

contexturality chosen for our description – belong separately to additional and different contexturalities. Our first datum may, e.g., be an intersection of the contexturalities α, β, γ, λ and the second may be intersected by the contextures β, δ, κ, π it. What we insist on, however, is that any two world data we choose to compare have at least one contexture in common. They may share in more but it is impossible that there is no contextural linkage between them at all. If that were the case then one of the two data would be "not of this world ".

Another way to put it is that for any two data which share a given contexture there will always be a third datum that is excluded from it. This is the meaning of Hegel's insistence in the face of the TND that there is a Third.—

When we compare the Platonic pyramid of the relations of the genus proximum, and the differentiae specificae with Table III, our comparison will not be complete unless we draw attention to a second difference – apart from the violation of the δδός ἄνω κάτω μία tenet by proto-structure – between the two pyramids. In the Platonic order of concepts only the very first bifurcation of the pyramidal structure may be interpreted as a total negation between positive and negative in general. Since the number of values represent a simple duality all the way down to the bottom of the pyramid, all subsequent bifurcations lead to partial negations. This is why a logic based on the principle of value duality has to stay within a single contexture and cannot cross its boundaries. The pyramid of proto-structure, on the other hand, does not deal with partial negations at all. Its ever widening scope is produced by the acquisition of – new values and consequently adds new contextures in addition to the first on top which it shares with classic logic, if we just make a general comparison. However, since any value (and its total negation) may be chosen as an ontological departing point for a two-valued system, we may consider the pyramid of protostructure as an ontological grid which describes the mutual positions of single contextures.

Furthermore: since classic logic recognizes only a single contexture the relation of concepts to numbers remains, notwithstanding the work of Kurt Gödel, rather undefined. What Gödel has demonstrated is that logic is capable of arithmetization. But his arithmetization concerns only the extensional domain of logic and bypasses those intensional relations where dialectical principles come into play. However, if we proceed from a single contexture to poly-contextural structures by increasing the number of total negations, a much closer connection between concept and number is established. We shall take the first step in this direction by attaching numbers to our proto-structural grid. This will give us the opportunity to discuss in Part III some of the aspects of a poly-contextural ontology and its logical consequences.

Part III : Platonic Hierarchy and Contextural Heterarchy

When we developed a pyramid of proto-structure we did so by adding with every step down one new place for value occupancy. This was done in a twofold way: we either repeated the original symbol or we added a new symbol. We shall from now on call the first method of increase "iteration" and the second "accretion." The symbol sequences outside the dotted lines are, as Table III shows, fully iterative on the left side and on the right side fully accretive. What is inside the dotted lines, is partly iterative and partly accretive with changing ratios between iteration and accretion. It is now very simple to attach numerical values to each of these symbol sequences by counting the number of

symbols that make up the length of a sequence and by counting the number of accretions it contains. Our first symbol "a" will be counted as the first accretion, and by putting the number for the length of the sequence first and for the degree of accretion second, and separating both numbers by a colon, we obtain for $\begin{matrix} a \\ a \end{matrix}$ the numerical expression 2:1 and for $\begin{matrix} a \\ b \end{matrix}$ consequently 2:2.

Table V

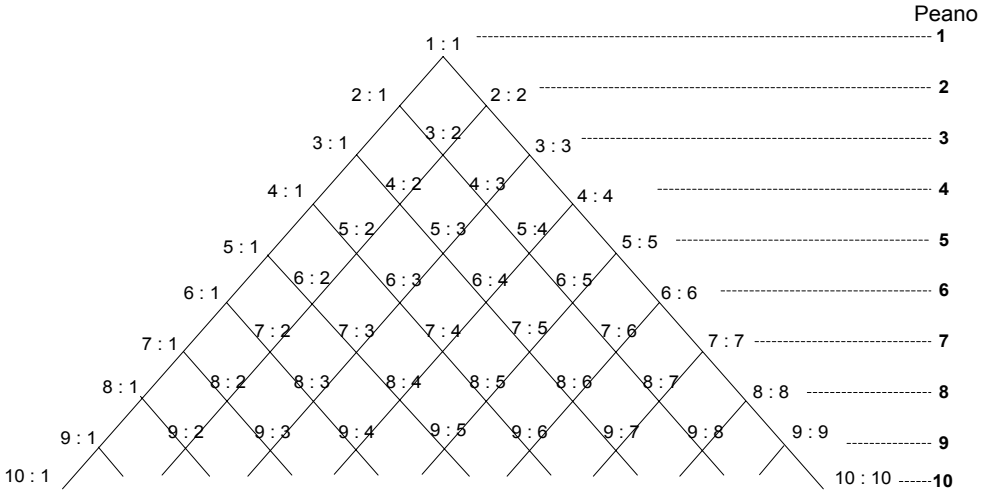


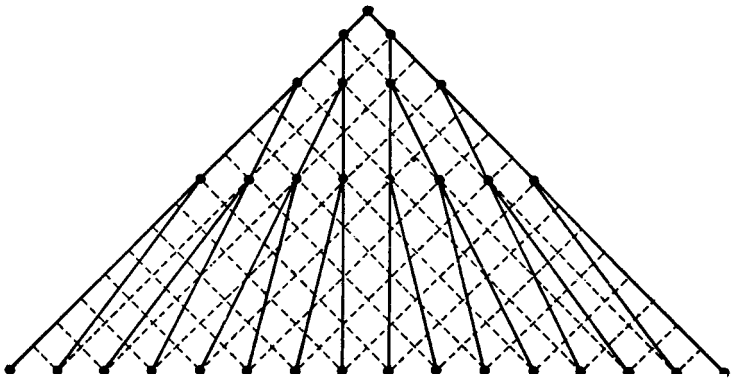
Table V shows this numerical pattern up to 10 places. On the right side we have written the familiar sequence of natural numbers as defined by the axioms of Peano and which represent the antique tenet that the way of counting up and counting down is one and the same. Within the pyramid we have again separated the numerical sequences at the extreme right and the extreme left by dotted lines from what is inside the pyramid. There is only one way to go from 1:1 to 10:1 and back. There is also only one way to do this between 1:1 and 10:10 However, if we want to count from 1:1 to – let us say – 10:5, there are already 126 ways to choose from. These choices increase very rapidly and, if we would proceed to the number Of 20:11, the ways we could count from 1:1 on would amount to 184756 different sequences. The increase of choices for any n : m can be derived from the formula

$$\binom{n}{m} = \frac{n!}{(n-m)!\,m!}$$

In other words: we can read them off the table of binomial coefficients.

In order to use proto-structure as an ontological grid for contextures we shall project the Platonic pyramid in various ways onto proto- structure, as will be demonstrated by the following 3 Tables. In Table VI we have superimposed the Platonic pyramid in such a way onto proto-structure that the apex of the two-valued pyramid coincides with 1:1 Proto-structure is indicated by dotted lines and we notice that the dichotomies of classic logic only start from certain intersections of the protostructural grid which are separated by increasing intervals determined by the squares of natural numbers. It seems that this relation between logical dichotomy and the squares of natural numbers was already discovered in the Platonic academy and some scholars ascribe it to Plato himself.

Table VI



On the next Table VII we have moved the apex of the Platonic pyramid one step down, and we have taken the left side of the bifurcation at the top so that the apex is now located at point 2:1 of our proto-structural grid. But we have also put into the same grid a second Platonic pyramid starting at 15:11 to illustrate our point further that this grid encompasses an infinite variety of two-valued contextures. 15:11 is, of course, quite arbitrary as a starting point, and we might as well have used any other intersection of the dotted lines.

Table VII

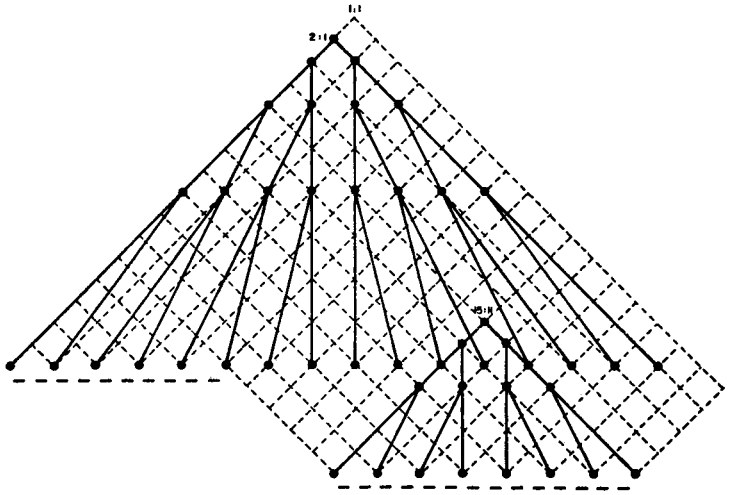
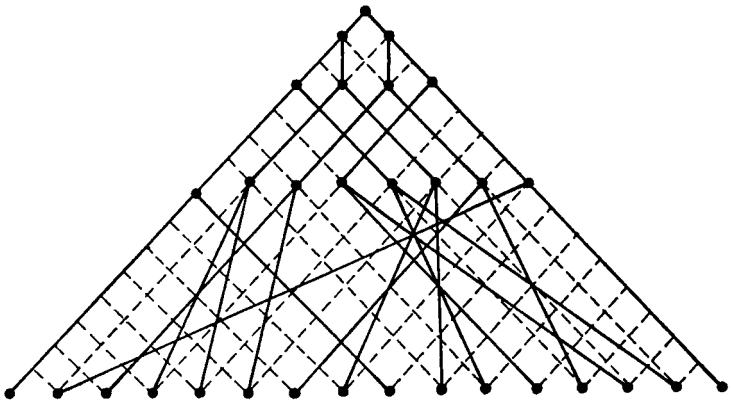


Table VIII finally, was drawn to remove the prejudice that a Platonic pyramid, if projected against the background of protostructure, must necessarily have a symmetrical

Table VIII



shape. In Table VIII we have moved the apex of the two-valued pyramid back to 1:1 And for the first two steps down we have repeated the previous pattern. For the next step down (from 8:1 to 8:8) we have still adhered to symmetry but made the lines of the dichotomies cross each other. From the eighth level of proto-structure down to level 16 we have abandoned the principle of symmetry and drawn our bisecting lines indicating two-valued dichotomies in quite an irregular manner. This was done to show that what is logically relevant in the Platonic pyramid apart from the principle of duality is only the tenet ὁδὸς ἄνω κάτω μία. Since one can go only from one heavy dot to the next on the levels 1, 2, 8, 16 and cannot change straight lines at any intersection in between, the principle that the way up and the way down is one is still preserved, and that is all that matters. Our configuration of the heavy continuous lines still represents the Platonic pyramid although the eye may have difficulties recognizing it as such. Our nonsymmetrical Platonic pyramid still constitutes an absolute hierarchy in a world where everything has a common ontic measure. But having a common ontic measure is only a different expression for saying that everything belongs to the same contexture.

Since we have demonstrated the origin of proto-structure we know that our grid determines only the relative positions of individual contextures to each other in a Universe where only one ontological datum (or one symbol) is permitted to be iterated. In case we discover that this does not yield a sufficient number of contextures, we may proceed to a more elaborate grid by stipulating that a second, a third, a fourth and finally any symbol may be iterated. If we still stick to the requirement that the placement of the symbol is irrelevant, we obtain a configuration which we have called (in a different publication) deutero-structure [6]. By again projecting contextures – but this time onto deutero-structure – we obtain richer relations between the single contextural domains and, of course, even more contextures. However, since Science is insatiable in its demand for precision in details, in the next step we may require that even the placement of a single symbol in an individual sequence may be relevant with regard to the relative positions of contextures to each other. This leads to a third and ultimate grid which the author has formerly called trito-structure.

So far we have dealt with radically formalistic techniques. But since our exploration of the world will always face the problem of the opposition between pure form and matter in the sense of content of the form, we can deal with this problem in the following way: First let us remember that we obtained proto-, deutero-, and trito-structure by dealing only with empty places from which value occupancy had been removed. The letters a b c d … in Table III signify nothing but empty places which can be arranged according to certain rules. This remains so in deutero- and trito-structure. But after having reached this maximum of structural configurations, we may reintroduce values into these configurations of empty places as their contents. Relative to the empty place the actual value which is inserted is something entirely contingent. In other words: the relation between place and occupying value corresponds to the distinction between form and matter.

However, this essay is not the proper place to follow this trend of thought any further. In fact, it cannot be fully discussed unless the relation between pure form and number is further developed. According to Plato, numbers occupy an intermediate place between the empyrean realm of Ideas and the empirical world of our sense. If this doctrine is true – and so far it has not been refuted – then it is impossible to apply trans-classic

(many-valued) logic directly to our physical world. It can only be done through the mediation of numbers.

Epilogue

What remains to be discussed is the significance of the concept of contexturality to the phenomenon of Life. It has been an ancient belief that Life, Soul or Subjectivity are phenomena which have no ontological grounding in our physical Universe. If we are to believe Socrates in the Dialogue "Phaidon" the Soul stems from a transcendent world and has strayed into this mundane world only to return after death into the unfathomable Beyond. If we divest this idea of its mythological connotations, there remains an abstract pattern of thinking which, properly modified, will have to be recognized as valid. We shall formulate it as follows: Between the inanimate phenomena of this Universe and the phenomenon of Life or Subjectivity there exists a logical break of contexture. If we speak of Life, Consciousness, Soul, Thought or Will we refer to an as yet unexplored property of the Universe which we shall call its discontexturality. What classic science has investigated so far is a subjectless Universe; and a subjectless Universe presents us with a rigorously mono-contextural structure. The property of discontexturality has no place in it. But when early Man discovered that this Universe also harbored the phenomenon of animated matter there was no other way to explain it but to say that Man had not only to deal with the forces of this World but in addition with trans-cosmic powers that broke into this World from an unapproachable Beyond. When the world religions speak of Heaven, or Hell they refer, in fact, to the phenomenon of discontexturality. But since every higher religion is coupled with the unshakeable belief that this earthly realm is mono-contextural, discontexturality automatically assumed the function of the borderline between physical reality and a spiritual Beyond.

On the other hand, the turn from classic to trans-classic thinking means that the mono-contextural concept of Reality is abandoned and replaced by a poly-contextural theory of Existence which makes room for the phenomenon of Life within this Universe. In a poly-contextural Universe we do not have to consider Life as an element totally alien to inanimate matter, because matter in itself already contains the seeds of Life in its dialectical contraposition of Being and Nihility.

It is, of course, still valid – up to a point – to consider the "material" substratum of this world as mono-contextural (naive materialism). But it will be necessary to consider all living organism as poly-contextural structures.

For the classic tradition there is a complete break between Life and Death. It is theoretically, although not practically, possible to fix the moment of Death as the time when the Soul departs from the body. From the poly-contextural aspect of a living body this is on principle impossible, because Death means only a gradual decrease of the discontexturality of Matter.

We are beginning to learn that the discontexturality of a human body, e.g., is enormous; the numbers of contextures that are involved are superastronomical. And since the phenomenon of discontexturality also involves the relation of an organic system to its environment it is quite legitimate to say that something may be alive relative to one environment and dead relative to another – an assumption that would be absurd if we

defined Death as the departure of a unit Soul from inert matter it had previously animated but has ceased to inhabit.

One final word regarding the "secularization" inherent in the concept of discontexturality: when we say that the immanence of earthly existence is separated by a metaphysical abyss from the transcendence of Heaven and Eternity we imply, first, that "Being" in our physical world is not the same as the "Being" of Heaven or Hell. In other words: there is an ontological difference between the two, as all great world religions have insisted. Second, we postulate that all our subjective stirrings as perception, feeling, willing, and thinking will break down at the barrier between the Here and There.

The Beyond is only conceivable as a mysterium of which we may know only by divine Revelation.

It should be kept in mind that, if we postulate a polycontextural Universe, the barriers of discontexturality which now cut through this empirical world, have lost nothing of their intransigency by being multiplied. But just the same the situation is different. Since the classic tradition permits only one discontexturality, i.e., that between the so-called physical and the so-called spiritual there can be no such thing as linking two elementary contextures into a compound contexture, for this would require a minimum of three contextures. One of the three would have to mediate between the other two. In other words: we would be provided with a contexture describing the phenomenon of discontexturality. This is the point where dialectic logic starts.

The point is reflected in theology in the statement that the almighty God rules Heaven *and* Earth. In order to give credence to this claim theologians have dogmatized that the Divine has to be understood as a Trinity – a dogma which again is capable of secularization. However, as soon as we admit the possibility of a trinitarian compound structure, the gates are open for the acceptance of compound contexturalities embodying an infinite sequence of higher complexities.

Notes and References

1. In order to clarify the mutual positions of Being and Nothingness it might be said that they are distinguishable as domains but indistinguishable with regard to their range.
2. See G. Günther, "Cybernetic, Ontology and Transjunctional Operations" in Self-Organizing Systems 1962, M. C. Yovits, G. T. Jacobi, and G. Goldstein (eds.), Spartan Books, Washington, D. C, p. 313-392. There the discontexturality of a value is established by its having a rejection function.
3. Hegel, Cf. "Wissenschaft der Logik", WWIII, Meiner (ed.), 66-67, 1923.
4. G. Günther, G. "Natural Numbers in Trans-classic Systems", BCL Report No. 3-4, AFOSR 68-139-1, AFOSR 70-1865, Department of Electrical Engineering, Engineering Experiment Station, University of Illinois, Urbana, 42 pp. (1970)
5. It is significant that such recent handbook of Logic like Norman L. Thomas "Modern Logic", first published in 1966, refers to many-valued logic only in a footnote (P. 92) Of two (!) lines. (Publ. Dames & Nobel, New York, fifth printing, 1970)
6. See again BCL Report – No. 3.4 (Nov. :1, 197o) and G. Günther, "Time, Timeless Logic and Self-Referential Systems" in Annals of the New York Academy of Sciences, 138, p. 396-406, (1967)

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Cybernetic Ontology and Transjunctional Operations

by Gotthard Günther *)

INTRODUCTION

This essay presents some thoughts on an ontology of cybernetics. There is a very simple translation of the term "ontology". It is the theory of What There Is (Quine). But if this is the case, one rightly expects the discipline to represent a set of statements about "everything". This is just another way of saying that ontology provides us with such general and basic concepts that all aspects of Being or Reality are covered. Consequently all scientific disciplines find their guiding principles and operational maxims grounded in ontology and legitimized by it. Ontology decides whether our logical systems are empty plays with symbols or formal descriptions of what "really" is.

The following investigation arrives at the result that our present (classic) ontology does not cover "everything". It excludes certain phenomena of Being from scientific investigation declaring them to be of irrational or metaphysical nature. The ontologic situation of cybernetics, however, is characterized by the fact that the very aspect of Being that the ontologic tradition excludes from scientific treatment is the thematic core and center of this new discipline. Since it is impossible to deny the existence of novel methods and positive results produced by cybernetic research, we have no choice but to develop a new system of ontology together with a corresponding theory of logic The logical methods that are used *faute de mieux* in cybernetics belong to the old ontological tradition and are not powerful enough to analyze the fresh aspects of Reality that are beginning to emerge from a theory of automata.

The first section of this essay deals with classic ontology. The second is devoted to some perspectives of a trans-classic ontology. Sections three and four try to develop a new theory of logic capable of meeting the demands of cybernetics better than the two- or many-valued systems currently in use. In the first two sections the philosophical view-point dominates. In the last two, technical problems of logic are accentuated.

The author strongly suspects that a majority of readers will hold the opinion that it would have been amply sufficient to restrict the investigation to Section 3 and 4 and to forget about the ontologic prelude of Section 1 and 2. The consensus that basic "metaphysical" reflections about logic have little or no practical value at all is widely spread. There is even some justification for this belief and it may be safely said that, as far as our two-valued traditional logic is concerned, the cyberneticist will gain nothing by submitting his logical procedures to a renewed scrutiny of its fundamental presuppositions. This logic is in its basic features now more than two thousand years old. A long historical process has worked its ontology into the very marrow of our

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bones, so to speak. We use this ontology with reasonable precision without being in the least aware of doing so.

There seems to be no reason why this happy and comfortable state should not continue. Einstein's widely quoted exclamation: "Der liebe Gott spielt nicht mit Würfeln"[+)] is a poignant expression of the deep-seated belief in classic ontology. And everything might be very well, indeed, except for the advent of transclassic calculi which demanded an ontologic interpretation. From then on, the logician was faced with an alternative. He could either try to interpret his new procedures in terms of the Aristotelian ontology or he could assume that a many-valued system is incompatible with the classic foundations of logic. This second part of the alternative involves, of course, a much greater risk. So it is understandable that Jan Łukasiewicz looked for ontological support in Aristotle's *Organon* when he introduced a third value into logic. It is important to know that he succeeded to a certain degree and that he was able to find a philosophic interpretation for a calculus with three values, and for another one with a denumerably infinite number of values. This happened between 1920 and 1930. It is quite significant, however, that after about ten years of research he was forced to admit that he could not find any ontologic significance for calculi between three and an infinite number of values. Since then hardly any progress has been made in this direction. Four- five- and other finite n-value systems have been used with practical applications but without any genuine insight into their basic ontologic significance. C.I. Lewis's sceptical statement with regard to many-valued systems, that "the attempt to include all modes of classification, and all resultant principles would produce, not a canon, but chaos" still stands unchallenged [1a]. For the first time the unity of logic is endangered! To preserve it, competent logicians have suggested that formal logic should be restricted to two values.

We are going to show that this suggestion is untenable. But so is the assumption that many-valued theories should be restricted to interpretation in terms of classic ontology. There is no doubt that this can be done within certain narrow limits and valuable results have been obtained with such procedures. Jack D. Cowan´s *Many-valued Logics and Reliable Automata* is a recent and notable example of this method[1b]. We should be very clear about the fact that the interpretation of many-valued systems on the basis of Aristotelian ontology is by no means "false". It is quite legitimate. In fact a vigorous continuation along this line is absolutely necessary.

However, there is another aspect to the question of the relation between a formal logic and its ontology. Is it *possible* to *exploit the immense capacities of many-valued* systems if we use them only to analyze what the classic tradition calls Reality ? This author confesses that the present use of many-valued logic reminds him of a man who might spend a fortune on a Ferrari racer in order that his wife should have transportation to the super-market.

An ontologic analysis of many-valued structures shows that only a tiny, almost infinitesimal, part of them coincides with the concept of Being or Reality that we have inherited from the Greeks. If we intend to use the full range of logical possibilities now

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[+)] Transl.: "God does not play with dice."

[1a] C.I. Lewis; Alternative Systems of Logic, *The Monist*, XLII 4, P. 507 (1932).

[1b] J.D. Cowan: "Many-Valued Logics and Reliable Automata," *Principles of Self- Organization*, ed. H. Von Foerster, G. W. Zopf, Pergamon Press, London, PP. 135-179 (1962).

available to us but still cling to ancient ontological concepts, the result will indeed not be a canon but logical chaos. The basic conceptual foundations with which a logic meets Reality are established as far as two-valued theories are concerned. But with regard to many-valuedness we have not even started to lay the proper foundation. An ontology is nothing but a very general prescription of how to use a logic in an existing world. It tells us how much of this world is approachable by exact scientific procedures. It is the aim of this essay to show which specific data of Reality that the classic ontology judged to be "irrational" or "transcendent" are within the grip of cybernetics if a certain type of many-valued logic is applied. For this very reason we claim that a careful analysis of the ontologic foundation of cybernetics is an eminently practical undertaking. The cyberneticist may find it useful to learn about a new way to interpret transclassic systems of logic. He should therefore not begrudge us the time and the effort to get acquainted with the contents of Sections 1 and 2.

This is a first attempt to outline an ontology for cybernetic logic. The author is aware of its considerable shortcomings. Among other things it is too abbreviated. But time was short and did not permit a more detailed analysis. The author hopes to make up for it in the second volume of his *Idee und Grundriss einer nicht-Aristotelischen Logik* which is in preparation.

The present essay deals only with one phenomenon, which will be called subjective self-reflection. Some of its elementary features are already recognizable in very primitive, inanimate systems. Nevertheless we shall focus our attention on its highest and richest representation, the self-awareness of Man. It may seem more reasonable to start with the simple manifestations of self-reflection in elementary models of self-organizing systems. Alas, this is not possible for a formal logic which claims general ontological validity for all structures of self-reflection. What will be valid for the self-awareness of man will also be valid for systems of lower reflective organization. But not vice versa. It is not possible to develop a new ontological theory of logic by starting at the bottom. Aristotle did not do so. The general principles of his theory of thinking which stood us in good stead till the advent of cybernetics were developed at the very outset of the evolution of Western science. Aristotle started with an answer to the primordial question: what is, "logically speaking", objective Being? We try to follow a great example if we pose and try to answer the question: what is "logically speaking" subjective self-awareness?

1. REMARKS ON CLASSIC ONTOLOGY

Philosophy has played a negligible part in the development of modern science since the times of Newton and Leibniz. The reasons are rather obvious and have frequently been stated. Descartes, Pascal, and Leibniz created the mathematics of their period out of the spirit of metaphysical problems. And Newton´s great work *Philosophiae Naturalis Principia Mathematica* not only carried the word philosophy in its title, but fully deserved this label because the transcendental problem of the relation between motion and time played a decisive part in the development of his theory of "fluxions". But then the ways of philosophy and exact science (including mathematics) begin to part. Kant´s philosophical speculations about the mutual relations of space and geometry on the one hand, and time and arithmetic on the other were actually refuted by Euler and

d´Alembert even before they were stated in the Critique of Pure Reason[1]. For Hegel the mathematical type of thinking had nothing to do with philosophy. And Schopenhauer´s ideas about the exact sciences of his time show a complete lack of understanding of the very essence of mathematical or experimental reasoning. Since then the regrettable alienation between philosophy and science has progressed even further. What might be the most profound metaphysical investigation of our own time, the ontological thought analysis by Martin Heidegger, remains intrinsically incomprehensible to the exact scientist or mathematician. It is not the fault of either side. This alienation has unfortunately provoked indifference, contempt, or even outspoken enmity against philosophy in the scientific camp. Perhaps the strongest and most radical expression of the present discord between philosophy and science is represented by the following statement of a well known thinker in the scientific camp: "Es gibt keine Philosophie als Theorie, als System eigener Sätze neben denen der Wissenschaft". (There is no philosophy as theory, as a system of statements *sui generis* apart from those of science.[2]

It seems a rather hopeless task under the circumstances to recommend some philosophical considerations from the field of ontology to the present-day scientist. Yet the attempt has to be made; the radical developments that have taken place within Science during the last decades, have made us suspect that certain fundamental philosophical concepts and presuppositions on which all our scientific efforts are (more or less unconsciously) based are in dire need of a thorough reexamination. The recent arrival of the youngest member of the scientific family, cybernetics, has made this suspicion almost a certainty[3]. Moreover, there is a special reason why the ontologist is interested in this situation. Formal (symbolic) logic, which has so often served as the arbiter in scientific controversies, is at present unable to help: its explosive expansion since about the middle of the last century has made the security of its own foundations dubious. Today it is still impossible to evaluate the effects which such discoveries as those that have come to us from Kurt Gödel and others will have on the future development of this discipline. The ontological basis of logic itself is in question, proof of it is the impossibility of resolving the claims of Intuitionism against Formalism and Platonism at this juncture[4].

There is no escape! When the formal logical foundations of science and mathematics become doubtful, the issue automatically reverts back to the ontological sector of philosophy. But even now the ontologist hardly dares offer his services: he knows only too well how unwelcome his reflections are, even under the present mental tribulations. The shout of logical positivism that the metaphysician is a fictioneer still reverberates loudly in the Hall of Science. But lately events have taken an ironic twist. The scientists themselves have invaded ontology. W. Heisenberg did so some time ago with a very

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[1] Oswald Spengler: *Der Untergang des Abendlandes*, Vol. I, C. H. Beck, München, p. 163 ss (1923).

[2] Rudolf Carnap: Die alte und die neue Logik, *Erkenntnis* I, p. 2 3 (1930).

[3] G. Günther: *Das Bewusstsein der Maschinen*, AGIS Verlag, Krefeld-Baden Baden (1957) for the necessity of new philosophic foundations of cybernetics. (Note_vgo: a third edition appeared in 2002)

[4] Wolfgang Stegmüller: *Metaphysik, Wissenschaft, Skepsis*, Humboldt-Verlag, Frankfurt a. Main-Wien, pp. 232-241 (1954).

valuable essay *Kausalgesetz und Quantenmechanik*[5]. E. Schrödinger gave in his Tarner Lectures[6] a very competent exposition of the ontologic relations between consciousness and world. As far as cybernetics is concerned one has only to mention W. S. McCulloch, whose articles offer us quite concentrated doses of metaphysics[7] and Norbert Wiener´s essay on *Newtonian and Bergsonian Time* [8] which in our opinion refutes certain basic aspects of traditional metaphysics.

Since cybernetics is much younger than quantum mechanics and, ontologically speaking, less developed, the new ontological situation naturally is delineated most sharply in the statements of Heisenberg and Schrödinger. In the above-mentioned essay Heisenberg offers the following reflections: Kant introduces in his *Critique of Pure Reason* the law of causality as an *a priori* principle by demonstrating that without this principle we could never form the concept of an objective world that exists independently of the subjective thought-processes that take place within our consciousness. Kant poses precisely this question: what "mechanism" in our mind enables us to distinguish between a sequence of events that occurs exclusively in our psyche – for instance a sequence in a dream – and a sequence that takes place in the external world independent of our observation? It is evident, so the *Critique of Pure Reason* points out, that we need a formal criterion to make the desired distinction; for we are aware of objective reality, as well as of our dreams and fantasies, only as content of our consciousness[9]. Nevertheless, we obstinately believe that some of these impressions have their origin in a world outside the mind and others have not. The source of this conviction, Kant declares, is the category of causality, which makes us look at a specific series of impressions as a rigid temporal succession that our mind is powerless to alter or stop. And what our consciousness cannot modify and control must necessarily have an existence outside and independent of it. The law of causality appears thus as a criterion to distinguish between subject and object, between consciousness and world. If we look at our impressions without interpreting them as causally linked to each other, they can be understood only as "a play of imaginations with no reference to an object"[10].

Heisenberg quotes the relevant passage (where Kant demonstrates that causality is our mental mechanism for the distinction between Subjectivity and external Reality) and admits that, if we use this interpretation, we have obtained a genuine a priori principle[11]. As such it is, of course, irrefutable – for the very simple reason that this *a priori* principle does not make the slightest assumption about the factual contents of the external Reality. It only states that if we want to think of a Reality that exists independently of the subject who is aware of it, we cannot do so without using the category of causality. To put it differently: if we want to establish an absolutely objective natural science which completely describes Reality without reference to the

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[5] W. Heisenberg: Kausalgesetz und Quantenmechanik, *Erkenntnis* II, 2/3, pp. 172-182 (1931).
[6] E. Schrödinger: *Mind and Matter*, University Press, Cambridge (1959).
[7] W. S. McCulloch: Towards Some Circuitry of Ethical Robots, *Act. Biotheoret*. XI, p. 147 (1955); "Of I and It" (not published).
[8] N. Wiener: Newtonian and Bergsonian Time, *Cybernetics*, Wiley, New York, pp. 40-56 (1948).
[9] Kant: *Critique of Pure Reason*, B, pp. 232-256.
[10] "… ein Spiel der Vorstellungen…, das sich auf kein Object bezöge." See above Note 9, B, p. 239.
[11] W. Heisenberg: loc. cit. p. 176, "Es ist evident, dass eine solche Auffassung des Kausalgesetzes als a priori Postulat nicht widerlegt werden kann, da es über die Erfahrung nichs aussagt."

subjective origins of our scientific terms and concepts then everything must be understood in terms of causality. Laplace´s famous Spirit would face in his differential equations a world devoid of any subjectivity whatsoever. This relation between subject and object depicts the classic ideal of scientific knowledge.

This ideal, however, Heisenberg points out, cannot be pursued since the advent of quantum mechanics. A radically objective system of physics, with a dichotomy of Reality into "thing" and "thought" is now impossible: "the radically isolated object has, on principle, no describable properties"[12].

If Heisenberg´s claim remains valid, and there is overwhelming evidence that it will, an entirely new type of logic must be developed. However, the term *New Logic* has been grossly misused since the Cartesian Johannes Clauberg (1622-1665) first spoke of *Logica Vetus et Nova* [13]; it will therefore be necessary to state what should be understood if such an expression is used. *A system of logic is a formalization of an ontology* [14]! If there seems to be a need for a new logic a new concept of ontology must be formed and *vice versa* In the present situation, outstanding representatives of the physical sciences express viewpoints which are *de facto* statements from a new ontology. A new concept of logic is consequently called for. But since such a new concept can only be developed in contrast to our classic tradition and theory of thought, it will be useful to offer a brief sketch of the reciprocity of traditional logic and ontology.

The correspondence theory of logical and ontological structures dates back at least to the dialogues of Plato, the Aristotelian Organon, and the logic of the Stoics. During this epoch the question was raised (and answered): what are the formal and ontological requisites for making verifiable and generally valid statements about the objective world ? It was found that such statements are possible only if we assume that the laws of Nature (Being) and the laws of Thought are essentially identical but differ in their formal aspects. This formal difference between a mathematical law in physics and the corresponding law in logic is due to the fact that, in the first case a description of the external world is intended, while in the second case the mirror image of this world, as it is repeated in our thought processes, is the motive and semantic theme of our representation.

Thus the set of natural laws (objectivity) and the inverse set of the rules and structures of logic together form an enantiomorphic system of rationality. The two subsets of this system constitute a symmetrical exchange relation which is as simple as our familiar

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[12] W. Heisenberg, loc. cit.: "Wenn Kant gezeigt hat, dass für eine objektive Naturwissenschaft das Kausalpostulat die Voraussetzung sei, so ist dem entgegenzuhalten, dass eben eine in dem Sinne "objektive" Physik, d.h. eine ganz scharfe Trennung der Welt in Subjekt und Objekt, nicht mehr möglich ist … der völlig isolierte Gegenstand hat prinzipiell keine beschreibbaren Eigenschaften mehr."

[13] First published by Schalbruch, Amsterdam, 1691. It also seems that Clauberg first suggested the term "ontology." cf. J. E. Erdmann, "Grundriss der Geschichte der Philosophie" II, Whilhelm Hertz, Berlin, p. 33 (1878). About the misuse of the term "new logic" cf. G. Günther, "Die Aristotelische Logik des Seins und die nicht-Aristotelische Logik der Reflexion," Zeitschr. f. philos. Forsch. XX, 3; part I, pp. 360-381 (1958).

[14] This has been analyzed in detail in G. Günther: Metaphysik, Logik und die Theorie der Reflexion, *Arch. d. Philos*., VII, 1/2; pp. 1-4.4 (1957).

distinction between left and right. This exchange relation is defined by our traditional operator of two-valued negation. Any datum of experience is either positive or negative, objective or subjective, and no third term (*tertium non datur*) is allowed. The disjunction is exclusive and total. The classic tradition, in a time-honored expression, speaks of the metaphysical identity of Thought and Being. In the realm of the ultimate, absolute Reality, Thought and Being are the same. They can be distinguished only on a relative empirical level where they appear as opposites. But our ontologic tradition insists that even in this opposition they express the same meaning and represent only two different aspects of the same "subject-matter" as our language profoundly says. However, it should never be forgotten that these two empirical aspects of Reality constitute a strict exchange relation of two sets or subsystems of a universal enantiomorphic structure which is, as such, indifferent to the distinction between subject and object (Cusanus´ *coincidentia oppositorum*).

However, this system of classic (two-valued) ontology, successful as it has proved for the development of Western science, suffers from an enormous drawback. The symmetrical exchange relation and the resulting ontological equivalence of subject and object governs only the mutual relations between the two subsets as inverse totalities. It is not applicable to any individual member of either set. In other words, the context of terms that describe the structure of our external objective world permits not the slightest penetration by concepts that refer to the epistemologic subject of cognizance that comprehends and is aware of objects. We may either discourse about objective reality (i.e. nature) in ontological terms or we may refer to the perceiving subject in logo-logical concepts, but we are absolutely not permitted to mix the two. If we ignore this prohibition we invariably get lost in a jungle of contradictions and paradoxes. The very fact that we nowadays possess an accurate science and base on it a vast technology is due to an ontologic tradition which was reasonably strict in adhering to the principle of dichotomy between matter and form and between subject and object.

The two-valued character of our logical tradition from the time of the Greeks up to the present day[15] testifies to the fact that our logic is a faithful attempt to formalize the ontology of the ultimate parity of form and matter, or subject and object as it was expressed in the ancient maxim of the metaphysical identity of Thought and Being. As long as our logical endeavors are orientated to this ontology we have no right to speak of a new logic, despite the enormous amount of detail that has been added to the older system in the course of the past century. But our logic still insists that it is meaningful to conceive the idea of a thought-object being fully identical with itself and therefore capable of isolation. The assumed metaphysical parity of Thought and Being permits a consistent system of formalization (logic) only if we regard these two primordial components of Reality as a symmetrical exchange relation. But such a relation isolates the two components completely from each other. Mind and Matter belong to different metaphysical dimensions; they do not mix. There is no such division between the energetic and the material state of the Universe. The Einstein equation $E = mc^2$ states

[15] A striking example how little our traditional logic has deviated from its two-valued structure is J. M. Bochenski´s *Formal Logic*, Karl Alber, Freiburg, München, which was published in 1956. Research in many-valued logic was started by E. L. Post and J. Łukasiewicz in 1920. But Bochenski´s 640 page volume which was published 36 years later reserves only a little more than two and one half pages for this topic!

that energy may be converted into mass and *vice versa*. But there is no analogous formula for the conversion of thought into matter or meaning into energy. We know as an empirical fact that our brain is a physical system where certain largely unknown – but physical – events take place. These represent to the observer a combination of electrical and chemical data[16] producing a mysterious phenomenon which we might call meaning, consciousness, or self-awareness. In view of this fact we must either retreat into theology and speak of a supernatural soul which only resides in this body as a guest, or assume that matter, energy and mind are elements of a transitive relation. In other words there should be a conversion formula which holds between energy and mind, and which is a strict analogy to the Einstein equation. From the view-point of our classic, two-valued logic (with its rigid dichotomy between subjectivity and objective events) the search for such a formula would seem hardly less than insanity. The common denominator between Mind and Matter is metaphysical and not physical according to a spiritual tradition of mankind that dates back several millenia. The very structure of our logic implies this metaphysical belief.

But if Heisenberg´s statements about the mathematical inseparability of subject and object in a quantum-mechanical description of the physical world are correct, then it becomes impossible to subscribe further to our traditional ontology and its consequences in formal logic. However, the mental step implied is enormous, and should not be taken on the testimony of a single witness no matter how great his scientific reputation. We shall, therefore, turn our attention to Erwin Schrödinger´s more elaborate discussion of the problem.

In the main, Schrödinger´s ideas take the same epistemological trend as those of Heisenberg. He discusses in detail the principle of objectivation which interprets objects as ontologically isolated identities. This has led to great successes. But the price we have paid for it is indicated by the fact that "we have not yet succeeded in elaborating a fairly understandable outlook on the world without retiring, our own mind, the producer of the world picture, from it …"[17]. The principle of radical objectivation was undoubtedly necessary for the past period of scientific research and it will remain so for certain borderline cases.

However, since the advent of quantum mechanics in physics, of meta-theory in logic and mathematics, and, last but not least, since the emergence of cybernetics the scientific situation has changed so radically that a new appraisal of this principle is overdue. Schrödinger draws our attention to the fact that as long as our thinking objectivates without hindrance and inhibitions it "… has cut itself off from all adequate understanding of the subject of Cognizance, of the mind"[18]. And he continues: "But I do believe that this is precisely the point where our present way of thinking does need to be amended … That will not be easy, we must beware of blunders … We do not wish to lose the logical precision that our scientific thought has reached …"[18]. This is not a passing thought in the Tarner Lectures. On another page we find a similar statement where Schrödinger again admonishes us to give up "… the time-hallowed discrimination

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[16] John von Neumann: *The Computer and the Brain*, Yale University Press, New Haven, p. 42 (1958).

[17] E. Schrödinger, see Note 6, p. 66.

[18] E. Schrödinger, see Note 6, p. 54s, cf. also p. 38.

between subject and object. Though we have to accept it in everyday life for ´practical reference´ we ought, so I believe, to abandon it in philosophical thought"[19].

Unfortunately, that seems to be easier said than done. Schrödinger himself draws our attention to a very peculiar relation between subject and object when he remarks: "the reason why our sentient, percipient, and thinking ego is met nowhere within our world picture can easily be indicated in seven words: because it is itself that world picture. It is identical with the whole and therefore cannot be contained in it as a part of it"[20]. Yet common sense and daily experience tell us that our thinking ego is a content of this world which science describes as an utterly subjectless context of existence. The Tarner Lectures call this an "antinomy" and refer to it with the following remarks: "The thing that bewilders us is the curious double role that the conscious mind acquires. On the one hand it is the stage, and the only stage on which this whole world-process takes place, or the vessel and container that contains it all and outside which there is nothing. On the other hand we gather the impression, maybe the deceptive impression, that within this world-bustle the conscious mind is tied up with certain very peculiar organs (brains) … On the one hand, mind is the artist who has produced the whole; in the accomplished work, however, it is but an insignificant accessory that might be absent without detracting from the total effect"[21].

If Schrödinger states that the phenomenon of consciousness or self-awareness has no legitimate place in our world picture because it is itself this very picture, he says in effect, that to be a subject means to be a mirror for an object. But since no subjects are to be found in this world this mirror must be an object too. The conclusion is unavoidable that if we use the term "subject" we actually mean a special class of objects which have the mysterious quality that they can reflect any other object in such a way that not only the object but the process of reflection is mirrored. Fichte significantly called the subject (ego) an "image of an image" and in another context "the image of a capacity" (to have images)[22]. So there is nothing but objects and "images". And insofar as a subject "exists" it does so only as an object. Qua subject it simply isn´t there. In fact it is nowhere. No wonder classic ontology delivered a startling dictum through the person of William James who published, in 1904, an essay: "Does Consciousness Exist"?[23] He first notes that Kant in the *Critique of Pure Reason* weakened the philosophic concept of "soul". He replaced it with his concept of the transcendental ego which in its turn attenuated itself to the "thoroughly ghostly condition" of a *Bewusstsein-überhaupt* (general consciousness) "of which in itself absolutely nothing can be said[24]. James´ careful analysis finally leads to the assertion that consciousness does not exist! "That entity is fictitious, while thoughts in the

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[19] E. Schrödinger, see Note 6, p. 51.
[20] E. Schrödinger, see Note 6, p. 52.
[21] E. Schrödinger, see Note 6, p. 64s.
[22] J. G. Fichte: *Die Bestimmung des Menschen*, W. W. II, ed. J. H. Fichte, Mayer und Willer, GmbH, Leipzig, p. 245 (1844); N. W. W. I, p. 428.
[23] W. James: Does Consciousness Exist? *Journal of Philosophy, Psychology and Scientific Methods*, 1, 18, Sept. 1 (1904).
[24] Quoted from *Essays in Radical Empiricism*, ed. R. B. Perry, Longmans, Green and Co., New, York, p. 2 (1947).

concrete are fully real. But thoughts in the concrete are made of the same stuff as things are"[25].

This conclusion may sound somewhat melodramatic, but it does not come as a surprise to the student of the history of Western science. He knows that all scientific endeavors of the past are based on the ontological proposition that every law that contributes to a verifiable description of Reality must be resolvable into statements about objects and objective events, because the terms that our cognitive mind forms as categories of mental comprehension are at the same time ontic properties of things and their modes of physical existence[26]. This "metaphysical" identity of Thought and Being is, according to Aristotle, the fundamental prerequisite of any science that deserves the name. And we cannot deny that the faithful adherence to this ancient tradition has stood us in good stead.

However, this basic epistemologic attitude, which still dominates our thinking, entails, a fatal weakness. All our scientific terms – as they are developed on this Aristotelian ontological basis – retain a semantic ambiguity. They can, in their entirety, either be taken as a description of the Universe as the absolute Object or as the absolute Subject. In other words: there is nothing in our present theories of thinking to enable us to distinguish logically between a genuine object like a stone and a subject or center of consciousness that appears to us to be a pseudo-object if we locate it in the body of all animal or human and call it all ego. This is the relevant meaning in Schrödinger´s remark that the mysterious entity we are accustomed to call a subject is nothing but our world picture taken as a totality.

It is interesting to note that it has occurred to neither Heisenberg nor Schrödinger that this situation makes their suggested inclusion of subjectivity into our scientific world picture quite impossible. Our classic system of (two-valued) concepts represents an enantiomorphic structure of rationality where the object exhaustively mirrors the subject and *vice versa*. This system offers two and only two ways to provide us with an ontological description of the relation between subject and object. This relation may either be interpreted as a conjunction or as a disjunction. But these two interpretations are inextricably compounded. If we consider the relation between subject and object with regard to the totality of the world and define it as conjunctive, then both form a disjunction relative to any arbitrarily chosen part of the world. But if we take the opposite view and presume that their ultimate ontological relation is disjunctive, then their relation inside the world must necessarily be conjunctive. This is the law of duality of two-valued logic stated by the two DeMorgan expressions:

$$p \wedge q \equiv \sim(\sim p \vee \sim q)$$

$$p \vee q \equiv \sim(\sim p \wedge \sim q)$$

Since it does not matter from which angle we look at the situation we shall take our orientation in the following arguments mostly from the conjunctive viewpoint.

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[25] Loc. cit. p. 37.

[26] W. Windelband: *A History of Philosophy*, Macmillan, New York, p. 134 (1893). ´The general, the Idea, is, as the true Being, the cause of occurrence and change … On the other hand, the general. is in thought the ground by means of which and from which the particular is proved.´

If we assume that subject and object are the inverse unit elements of an enantiomorph system, then it is possible to make empirically conjunctive statements about subjects and objects in a context where all terms are uniformly designated. We do that in our discourse daily and think nothing of it. But, of course, everything we say about subjects is expressed in terms that designate objects. We cannot help it because there are no other terms available owing to the collaboration between the principle of objectivation and two-valued logic. We are so accustomed to this epistomological deficiency in our language that we make automatically and unconsciously the necessary allowances when we receive information of this sort. If somebody told his friend to pick up his wife at the steps of the Lincoln Memorial and he reported afterwards: I could not pick "her" up because I located only her body standing on the steps, that would be considered a very stupid joke. However, in a strict ontological sense the friend would have been right. Subjectivity cannot be located in this manner. And what could have been picked up was merely an "it", not a "she".

But if Reality is actually the conjunction of the inverse components of subject and object, and we insist on a precise scientific language which does not permit the liberties of everyday speech, we arrive by logical necessity at a duality of interpretations for our system of objective terms. H. Reichenbach has drawn our attention to the fact that this is what has actually happened in quantum mechanics. The Schrödinger wave equation guarantees logically a "strict duality of wave and corpuscle interpretation for free particles"[27]. This is the only way to obtain an "exhaustive" description of Reality in purely objective terms. The contraposition of subject and object is transposed into Bohr´s rule of complementarity. The two quantum mechanical concepts of corpuscle and wave still designate objective reality. But the degree of objectivation that is represented by them is much lower than for corresponding terms of classic physics. What dilutes their ontological significance is their complementary contraposition[28]. The degree of objectivity that was formerly represented by a single concept is now distributed over two. This *property of distribution is the disguise under which the subjective component of our quantum mechanical terms conceals itself.*

Since we will later demonstrate that this element of distribution is the general logical criterion for determining whether a given theoretical system contains smaller or larger traces of subjectivity in its terms, it may be useful to explain a little further how it shows up in Bohr´s rule of complementarity. The so-called Copenhagen Interpretation of quantum theory starts from the fact that any experiment in physics must be described by using the two-valued classic terms of physical science. These terms cannot be replaced as an epistemological basis of our thinking because our consciousness assumes a two-valued structure whenever it contacts objective facts. Our classic theories of nature use these terms exclusively because they strive for that scientific "idealization in which we can speak about parts of the world without reference to ourselves"[29]. Quantum mechanics on the other hand maintains that this radical dichotomy between subject and object is a purely formal concept. Subject and object constitute a clear-cut

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[27] H. Reichenbach: *Philosophic Foundation of Quantum Mechanics*, University of California Press, Berkeley and Los Angeles, pp. 71 and 33 (1946).

[28] C.F. von Weizsäcker: *Komplementarität und Logik*, Die Naturwissenschaften, XXXXII, 19, p. 522 (1955). ´Die Komplementaritiät der Begriffe (schränkt) ihre Objektivierbarkeit ein.´

[29] W. Heisenberg: *Physics and Philosophy*, ed. R. N. Anshen, Harper & Brothers, New York, p. 55 (1958).

division of Reality only as long as we conceive the objective world as a self-contained totality and put it as such in contrast to subjectivity in general. But as soon as we want to observe part of the world the symmetrical character of our formal system of logic is affected and special provisions have to be taken to preserve it.

Heisenberg has described the epistemological imbalance of terms in quantum mechanics by making the statement that modern physics "starts from the division of the world into the ´object´ and the rest of the world". But dichotomy implies "already a reference to ourselves and insofar our description (of the world) is not completely objective"[30]. It is important that we are fully aware of the ontologic consequences of this statement. If the dichotomy radically separates object and subject so that the first represents all of the world and the second only our description of it, then this description would be completely objective. Our set of descriptive terms and the corresponding set of objective properties of the external world would represent a structural equivalence and not an implicative relation. There would be no Reflexionsgefälle (gradient of reflection) between the subject and the object. But the division which Heisenberg proclaims is not such a simple one. He places the object on one side and the "rest of the world" on the other. But the rest of the world means a conjunction of object and subject! This is exactly his point.

But if we accept this second dichotomy, and there is no reason why we should not, we will have to remember that in any description of objective Reality the two terms "object" and "subject" are inversely equivalent. This means: Heisenberg´s dichotomy is only acceptable if it is supplemented by a corresponding dimension which separates the subject from "the rest of the world". In this way we arrive at three ontologic dichotomies as the following table demonstrates:

object (O^O)	subject (S^S)
object (O^O)	object (O^S) < subject (S^S)
object (O^O) < subject (S^O)	subject (S^S)

The indices refer to the "als" (as if) category of transcendental logic. Something is thought of as having reference only to itself or as referring to something else. The distinction corresponds roughly to that of world in itself (an sich) and "world" as content of our awareness, and to that of consciousness as inner subjective awareness and consciousness as objective event in the external world. Heisenberg´s dichotomy implies that distinction, but it seems that he is not aware of what his "rest of the world" means. The division above the horizontal line refers to the "absolute" dichotomy of the classic tradition of logic which believed in the ideal of a radically objective description of Reality. The Copenhagen interpretation of quantum mechanics is represented directly below and further down its necessary corollary. If we represent the possible formal relations between O and S in symbolic form we obtain

$$O^O \equiv S^S \qquad (1)$$

$$O^O \supset (O^S < S^S) \qquad (2)$$

$$(O^O \wedge S^O) \subset S^S \qquad (3)$$

[30] W. Heisenberg: loc. cit. p. 56.

Formula (1) is always true if O^O and S^S have the same value and it is always false if their values differ. Formula (2) is invalid if and only if O^S is true and the conjunction of O^S and S^S does not hold. In Formula (3) this situation is reversed. This time the implication is not valid if S^S is true and again the conjunction does not hold. It is obvious that if Formula (1) holds then Formula (2) cannot stand alone. It must be complemented by Formula (3). Otherwise the value symmetry which the Copenhagen Interpretation expressly demands is destroyed. It is significant that a two-valued calculus of logic (as applied in quantum mechanics) cannot assign different values to S^S and S^O or to O^O and O^S. In other words: although the Copenhagen Interpretation acknowledges epistemological differences between S^S and S^O or between O^O and O^S, from the view-point of a formal classic calculus the indices are redundant.

This co-validity of the Formulas (2) and (3) points at two distinct phenomena of distribution of terms in quantum mechanics. There must be one type of distribution concerning the O^O-range describing the object) and another one in the S^S-range (developing the logical theory). We have already taken notice of Bohr´s rule of complementarity in this context and observed that the duality of corpuscle and wave indicates a distribution of subjectivity over two sets of objective terms. The second feature of distributivity shall be mentioned three paragraphs below. Whatever the epistemologic frame of a scientific discipline, the thinking that is done in it is nothing else but the mapping of a set of conceptual terms onto a field of objective data. The simplest case is represented by Formula (1). Here the set of S-terms corresponds one-to-one with the set of O-terms. But in order to give this two-valued system ontological significance either "S" or "O" must be declared as designated value. If we choose "O" we are entitled to state that our formulas provide us with an abstract picture of the objective world. But the subject as the onlooker, who has this image, remains an unknown x because "S" was not the designated value. In other words, the procedure of designation implies that the ontological character of either "S" or "O" must remain unknown. If "O" is the designated value, then we assume a mysterious "soul" that perceives a real world and knows about it in genuine objective terms. If, however, the designation favors "S" as for instance Fichte´s and Hegel´s logic does, then the resulting philosophy seems to know all about the subject but the genuine object, the thing-in-itself, disappears. Kant still admits its existence in the *Critique of Pure Reason* but emphasizes that we will never know anything about it. His successors Fichte and Hegel are not even satisfied with that. They demonstrate rather convincingly that the very concept of an isolated object-in-itself is a logical contradiction. That means we cannot even make meaningful statements which assert the radical objective existence of such things.

We have gone in such detail about this ontological issue because it is of overriding importance to understand why a two-valued theory of thought can never describe an order of Reality in which subject qua subject and object qua object co-exist. A logic in the usual sense of the word cannot be applied at all unless we designate a value. But as soon as we have done this we are committed. We cannot have it both ways. If we use our logic to describe the object, then the context of our terms is never applicable to the subject. But if our theory aims at describing the relations between our mental (subjective) concepts, then we do not obtain a picture of the objective world, only of its reflected image, with typical properties of reflection that the objects do not possess.

The peculiar epistemological structure of quantum mechanics stems from the fact that it uses a logic in which subject and object permit only an inverse transmission of terms but it applies it to a dimension of Reality where subjective and objective properties are inextricably mixed. The result is, as we have pointed out, a distribution either of objective terms over the range of subjectivity or an inverse distribution of subjective concepts over the field of objects. Our Formulas (2) and (3) indicate these reciprocal situations. The practical effect of this unusual situation can be described as follows: As long as no factor of distribution enters the picture, the case in classic physics, we use *two and only two* distinctly different values to describe *one single* object that is fully and unquestionably identical with itself. But as soon as we allow for distribution two things happen. On the objective side it becomes impossible to retain the concept of an object that has an indivisible identity with itself. Instead of it we obtain two pseudo-objects which complement themselves as mutually exclusive pictures of the objective component of Reality. This is the duality of the corpuscle-wave concept which mirrors the classic contraposition of the two logical values "positive" and "negative". In pre-quantum-mechanical physics only one value designates the object. Consequently it is sharply focussed and single. But from the very moment the physicist claims that it is impossible to separate non-ambiguously in his observational data the share of the subject and the object, *both* values have to be used for the description of what he sees. Hence the splitting of the identity of the object in its two images as corpuscle and wave. So much for the object and the rule of complementarity.

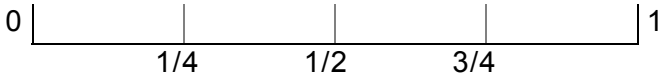
But in any science we can think of a comprehending subject facing a certain context of the world. If this context is changed, it must necessarily modify the conditions of thought under which the relevant context can be understood. This reciprocity is expressed in our Formulas (2) and (3). It means, as far as quantum mechanics is concerned, that the principle of distribution manifests itself not only in our description of objects and objectivity in general but also in the epistemological conditions that determine the logic of our scientific thought processes. We remember that on the classic level of epistemology we had two distinct logical values (true-false) on the subjective side facing one single self-identical object in the external world. Now the identity of this very same object is distributed over two complementary concepts of objectivity. But the argument applies both ways. The reciprocity of Formulas (2) and (3) implies that the principle of distribution should equally hold on the side of thought, affecting the rigid contraposition of our two values. And this is what happens indeed. "True" (T) and "false" (F) are distributed over each other; instead of the clear distinction between them which is expressed in Table 1:

Table I

F	T
1	0
0	1

we are forced to adopt a sliding scale of "mixed" values:

Table II



The result is that we can describe the properties of observed " objects" only in terms of probability functions. Not only external existence manifests itself in complementary forms. There is subjective complementarity too. "The *Knowledge* of the position of a particle is complementary to the *Knowledge* of its velocity or momentum"[31].

To prevent a misinterpretation of the term "subjective" as used by Heisenberg, by Schrödinger or the present author, it should be emphasized that it never means dependency on the *arbitrariness* of any subject, not even the impassioned scientific observer. Heisenberg has clearly stated: "The probability function combines objective and subjective elements. It contains statements about possibilities, or better, tendencies … but … these statements are completely objective: they do not depend on any observer"[32]. The expression "subjective" if used in quantum mechanics with regard to the corpuscle-wave duality and the probability of functions, *can never mean anything but that the logic applied uses its two values in a distributed state.*

With these remarks we conclude our presentation of the part played by subjectivity in modern physics. However, the definition of subjectivity as a phenomenon of value-distribution in logic and as ambiguity in the concept of the object (particle plus wave) that emerged from our arguments is not sufficient for the purpose of cybernetics. We have seen how the introduction of the subject into our scientific frame of reference changes the ontology of the object. But a parallel ontology of the subject has not yet been introduced. Its discussion will be our next concern.

2. TRANS-CLASSIC ASPECTS OF ONTOLOGY

The reasons why the logical properties of subjectivity disclosed in quantum mechanics do not by themselves satisfy the requirements of cybernetics can be stated in simple terms. Physical science is – quite rightly so – only interested in the description of genuine objects and of objective events. Subjectivity enters the picture only in a negative manner, as a lack of certainty and as a duality of terms weakening their power to designate objectivity. The subject as such, as a center of reflections with self-reference, is not the topic of any science with the methodological aim to explore this whole world the way it is given to us as the objective content of our consciousness. Even if the ideal of objectivity seems to be rather tarnished nowadays it still remains a regulative principle of scientific conduct.

Under the circumstances it might seem doubtful whether subjective consciousness could become the topic of a serious scientific treatment. It is true that we possess a very profound epistemological theory of self-consciousness, but it was developed by metaphysicians in India as well as in the Western World. Its terminology is suspect and, in its traditional form, almost useless for scientific purposes. On the other hand, present day cybernetics is so enamored of its imposing arsenal of hardware and of a

[31] W. Heisenberg: loc. cit. p. 49. The italics are ours.
[32] W. Heisenberg: loc. cit. p. 53.

terminology attuned to the radically objective character of physical models that there seems little chance these two shall ever meet.

Yet they must be brought together. When computer theorists pose such questions as: can machines have memory? do they think? are they able to learn? can they make decisions? do they possess creativity? we can see that subjectivity enters into cybernetics from the very beginning in a much stronger fashion than into physics. Nobody has ever seriously asked whether electrons think or whether they are gifted with the power of mental creativity. Classic, as well as modern, physics are not interested in the fact that our universe contains several groups of systems with such a high capacity for self-organization that they produce a mysterious quality called consciousness or self-awareness. It is quite different with cybernetics. This novel theory potentially encompasses every scientific discipline that, by its very nature, is obliged to recognize the actual existence of a plurality of centers of self-awareness which we commonly call consciousness. In his *Design for a Brain* Ross Ashby[33] has given a very clear exposition of the methodological situation that confronts us in cybernetics. He points out that the (originally subjective) category of "learning" can be defined in a way that has no necessary dependence on consciousness. But he significantly adds that the "observation, showing that consciousness is sometimes not necessary, gives us no right to deduce that consciousness does not exist. The truth is quite otherwise, for the fact of the existence of consciousness is prior to all other facts. If I perceive – am aware of – a chair, I may later be persuaded, by other evidence, that the appearance was produced only by a trick of lighting; I may be persuaded that it occurred in a dream, or even that it was an hallucination; but there is no evidence in existence that could persuade me that my awareness itself was mistaken – that I had not really been aware at all. This knowledge of personal awareness, therefore, is prior to all other forms of knowledge"[36]. From this it follows clearly, as Ashby has pointed out in another context, that "cybernetics has its own foundations"[34]. It should be noted that the concept of consciousness is not built into the foundations of physics – despite its empirical admixture of subjective elements. However, if Ashby is right (and we believe strongly that he is) that the existence of consciousness is prior to all other facts in cybernetics, then the ontological foundations of any cybernetic theory must differ essentially from those of physics. In the latter discipline we shall continue to search, despite all modern developments, for the basic laws of materiality. Materiality is what we mean if we imply that there is an outside world beyond the confines of our or any consciousness. It does not matter at all how diaphanous this idea of materiality has become during the last decades. There is some possibility it might even fade into the concept of a "self-field", the ultimate speculation of modern physics[35]; but even such a field would be an objective order of Reality. Objectivity has always meant and will always mean materiality. Ontologically speaking it makes not the. slightest difference whether we define materiality as that which we can see or touch, or whether we interpret it as a "hypostatized" field of self-interaction. It still remains the very same

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[33] W. R. Ashby*: Design for a Brain*, Wiley, New York, p. 11 (1952).

[36] An approximate idea of it in G. Günther: Das Bewusstsein der Maschinen, see Note 3.

[34] W. R. Ashby: *An Introduction to Cybernetics*, Wiley, New York, p. 1 (1956).

[35] A.W. Stern: *Space, Field and Ether in Contemporary Physics*, Science, 116, pp. 493-496 (1962). See also O. L. Reiser: Matter, Anti-Matter and Cosmic Symmetry, Philosophy of Science XXIV 3, pp. 271-274 (1957).

objective "It" as the trivial objects of our daily life. The concept of consciousness does not enter into this picture at all. In fact it has been irrelevant for the entire development of Western science from the Greeks till this present century.

For cybernetics, on the other hand, the fact of self-awareness is fundamental. It follows that Man is about to enter a new epoch in his scientific history[34]. The transition from the physical sciences to that new group of disciplines which are originating under the general label cybernetics is so basic that the magnitude of this mental revolution is not yet fully grasped even by the cyberneticists themselves. We shall try to give an approximate idea of its size by starting from some principal statements made by Ashby. He remarks in his *Introduction to Cybernetics,* under the very appropriate heading "What is New?", that "the truths of cybernetics are not conditional on their being derived from some other branch of science." Accordingly, "it depends in no essential way on the laws of physics or on the properties of matter ... The materiality is irrelevant, and so is the holding or not of the ordinary laws of physics"[37].

This leads to surprising conclusions. It will be useful, however, before stating them to give the working definition of cybernetics that Ashby offers under the same heading. He interprets this novel science as "the study of systems that are open to energy but closed to information and control"[38]. From a purely logical viewpoint this definition is somewhat preliminary and redundant, for the concept of control can to some degree be subsumed under information. However, it will serve, together with Ashby´s other remarks, as a good starting point for a general definition which might satisfy the ontologist. Since the distinction between "open to energy" and "closed to information" implies the irrelevancy of the material aspects of a cybernetic system one might describe cybernetics from the ontological angle as the study of a specific type of systems that must be described in terms presuming but not designating the materiality of the system. However, this definition also can only be provisional. It suffers from the fact that the designating character of cybernetic terms is only negatively circumscribed. Especially since we do not know how these specific types of systems should be defined in logical terms which do refer to its susceptibility to information. But we have already learned something of considerable importance: in our universe there exists a class of physical systems which have a non-material aspect. This aspect can be scientifically investigated! It can be treated experimentally, and we may build a new type of technology on it.

The transition of our thinking to this new outlook has come to us so gradually and partially disguised in the cloak of trustworthy traditional patterns of thinking that very few contemporary thinkers realize how radical the change has been and how many innovations it will induce in the future. The idea that we encounter in our universe phenomena that seem not only to have a nonmaterial aspect but in whom this aspect alone describes their essence is one of the oldest of mankind. We have ancient, cryptic words for it like Life and Soul. But these non-material manifestations of Reality were always considered the domain of religion and theology, beyond the reach of scientific treatment. Only in the nineteenth century did this outlook begin to change, when the influence of Kant, Fichte and Hegel made itself felt in the new scientific theories. Kant

[37] Loc. c it., p. 1.
[38] Loc. c it., p. 4.

had deprived the concept of soul of all metaphysical substantiality, declaring it to be a regulative principle of thought. Following in his steps, Fichte and Hegel developed the first full-fledged logic of consciousness: the secularization of the concepts of Life and Soul had entered its first phase. A significant new term was coined during this period: *Geisteswissenschaft.* The word "Geist" is untranslatable, and since 1871 we find it in English dictionaries as an adopted foreign word. It is interesting to notice that if we divest the word of all specific nuances with which the German tradition has impregnated it and penetrate to its logical core then it means nothing but an aspect of objective Reality that must be described in terms which are indifferent to the materiality of the objective context that is under discussion. But the idea of Life or Soul as a metaphysical essence that resides temporarily or even permanently as an alien in our empirical reality died hard. In natural science it survived for some time in the theory of vitalism. In philosophy it continues to plague us in many disguises like, for instance, the division between the humanities and science or the modern varieties of irrationalisms.

It seems to us that cybernetics is taking up the heritage of those ancient metaphysical traditions if it deals with that sector of Reality where the question of the material character of the observed phenomenon has become irrelevant. However, the range of the phenomena that belong to this category is enormous. It encompasses the whole scope of the Universe. To it belong all inanimate systems that show even the slightest degree of capacity for self-organization. It includes as a second group all organic systems from the simplest unicellular through the whole sequence up to man. And it encircles with its terms all historical institutions that have ever been or potentially could be produced by mankind. Nobody will find it difficult to see that the mental amplitude of our cybernetic theories surpasses any other scientific discipline that has been conceived since the times of Plato and Aristotle. One might say that cybernetics stands between the whole array of our individual sciences on the one side and philosophy on the other.

This exceptional position of cybernetics has not yet been fully realized by the scholars working in this field. And therefore, no serious need has been felt to provide this novel mental undertaking with logical foundations of its own. But foundations are necessary nonetheless. It should be evident that if cybernetics is of such scope that it comprises not only natural systems of both varieties, inanimate or animate but also historical institutions as self-organizing units, then the theoretical foundations of such isolated disciplines as physics, chemistry, biology, and sociology are ridiculously insufficient. And so are our present day mathematics, which are not yet prepared for a mathematical theory of consciousness and self-awareness. But if consciousness is a basic prerequisite for the behavior of certain self-organizing systems of animal type, we shall make little progress in the cybernetic analysis of animal or human behavior until we possess a mathematical method for the treatment of the still mysterious phenomenon of self-awareness. On the other hand it has been impossible, up to now, to develop the required procedures because the underlying logical concepts are still missing. The logic which science has used so far is minutely tailored to the needs of the classical concept of intellectual pursuit with its methodological ideals of excluding subjectivity from the formation of all theoretical terms and of being radically objective. It stands to reason that this attitude is worse than useless when the behavior of a system is due to its possessing self-awareness. And self-awareness is subjectivity, a phenomenon that can only be described in terms irrelevant to the materiality of the object it is related to.

The demand for a suitable new logic should be recognized in cybernetics more than anywhere else. And this investigation has imposed upon itself the task of furnishing the basic concepts for a formal theory of self-reflection that might satisfy the comprehensive demands of cybernetics. Since all previous sciences have derived their fundamental ideas and theoretical procedures from philosophy, as the history of human knowledge amply demonstrates, we shall turn again to this great source of primordial concepts to see what more can be learned from it.

The previous relations between philosophy and empirical science can be described briefly by stating that philosophy in its ancient pre-Greek form was the only universal "science" that encompassed all material as well as non-material aspects of Reality, and that investigated the prototypal relations between these aspects. What begins approximately with the Greeks is a process of mental comminution. Certain parts of knowledge undergo a subtle change. Philosophy itself remains unaffected, but these parts detach themselves from it and become independent bodies of knowledge. Geometry is an early example of the breaking off. After a slow start this process has continued without major interruption through the last two millennia. It persisted delectably during the Middle Ages, and after the Renaissance it accelerated rapidly. In the last century it has assumed such fantastic proportions and has split our knowledge into such a gigantic labyrinth of single sciences that no human brain is still capable of understanding its general context and meaning. It is only natural that the cry for a Unified Science was heard long before the arrival of cybernetics. But, although famous names like Łukasiewicz, Bohr, Russell, and Carnap were connected with it, one is forced to admit that the undertaking has not succeeded. It was predicated on the assumption that philosophy had dissolved itself in this process of comminution and that nothing was left. Its successor was supposed to be a special discipline among others, to be called "the logical analysis of scientific language"[39].

There were good reasons for believing that the attrition of the former substance of philosophy was complete. What seemed to be the last metaphysical stronghold of old-style philosophical thinking – the theory of, infinite actuality – had been conquered by George Cantor[40] during the last two decades of the nineteenth century. His theory of transfinite sets (*Lehre vom Transfiniten*) appeared to be a purely mathematical discipline; when, later on, paradoxes developed from it, no mathematician went back to the metaphysical origins of set theory. The solution of the difficulties was considered a merely technical affair of symbolic logic even if it meant resorting to such desperate

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[39] R. Carnap: *Logische Syntax der Sprache*, Verlag Julius Springer, Wien, p. 111 (1934). ´Philosophie wird durch Wissenschaftslogik, d.h. logische Analyse der Begriffe and Sätze der Wissenschaft ersetzt´.

[40] G. Cantor: Über die verschiedenen Standpunkte in Bezug auf das aktuale Unendliche, *Zeitschr. f. Philos. und philos. Kritik*, 88; pp. 240-265 (1886) - "Mitteilungen zur Lehre vom Transfiniten," I, *Ibid*. 91, pp. 81-125 and 252-270; continued as "Mitteilungen..." II, 92, pp. 240-265 (1888) - "Beitrage zur Begründung der transfiniten Mengenlehre I." Math. Ann. 46, pp. 481-512. Continued as "Beitrage... II," Ibid, 49, pp. 207-246 (1897). Also see E. Cassirer, *Substanzbegriff und Funktionsbegriff*, Bruno Cassirer, Berlin, pp. 80-87 (1910). ´Cantor hat, indem er in seinengrundlegenden Untersuchungen das System der transfiniten Zahlen schuf, zugleich alle die scholastischen Gegensätze des Potentiell- und Aktuell-Unendlichen, des Infiniten und Indefiniten wiederum heraufbeschworen. Hier scheinen wir somit endgültig von der Frage nach der reinen Erkenntnisbedeutung der Begriffe zu den Problemen des absoluten Seins und seiner Beschaffenheit hinüber gedrängt zu werden.'

measures as the restrictions that Brouwer, Heyting and other intuitionists wanted to impose on mathematics. At any rate after Cantor´s initial steps, there was no turning back; and although the Transfinite is not yet fully conquered, it has irrevocably been claimed as a mathematical problem and has thus lost its dignity as a metaphysical archetype. But does that really mean that the last bulwark of classic metaphysics has crumbled? Our answer is emphatically No. But since the proof of the pudding is in the eating we intend to demonstrate that there remains at least one genuine transcendental problem of the classic tradition awaiting its exact scientific treatment and subsequent solution. Incidentally, our claim of "at least one problem" does not exclude the possibility that there may be an infinite number of them; we strongly believe this to be the case. Metaphysics is by its very nature an *inexhaustible* source of transcendental categories offered for transformation into exact scientific concepts. In fact, that seems to us to be the intrinsic difference between philosophy and the positive scientific disciplines that have emerged and separated from it. The latter are in principle exhaustible and can be completed. The former can not! And this is our only guarantee that the well of human creativity will never dry up.

The problem that remains is covered – but not defined – by such questions as: what is life? What is consciousness? What is subjectivity? and finally: what is history? It seems strange to name in one breath such divergent and apparently heterogeneous topics.

Life which is assumed to be treated fairly well by Biology and History belongs to the humanities. Here metaphysics, which has fallen in such disrepute among scientists, proves its practical usefulness.

To the philosopher it has always been clear that such heterogeneous phenomena as Life and History have this in common: they both represent self-reflective systems. In other words, they display a subjectivity of their own. However, the very fact that this has been recognized at a very early date has hampered the scientific treatment of the phenomenon of subjectivity. It is a curious situation. The overwhelming number of metaphysicians in East and West agree that Reality as such can only be understood in analogy (*analogia entis)* to a self-reflecting subject. Spinoza even chose for ultimate Reality a term that indicated its self-reflective structure: *natura naturans.* But the very fact that this category seemed to point at the metaphysical secret of all Existence made the sober scientist shy away from it. He was always familiar with the concept of ordinary physical reflection. There he had no difficulty in regarding the world as a reflection (content) of his consciousness. But self-reflection is different. From its lowest forms as the spark of Life in the primitive organism to its highest manifestations in Man it denoted always a metaphysical essence, the primordial stuff that is the very core of Reality. The prejudice voiced by Spinoza that only an *intellectus infinitus* may understand self-reflection still dominates our scientific thinking. There is a silent consensus that it is impossible to develop a strict formalism for self-reflection.

Of course, as long as self-reflection, the essence of life, consciousness and subjectivity, is considered to be something mystical and supernatural it would be hopeless to look for an exact formal logic that describes its structure. It would be even more absurd to expect a mathematical treatment of it. How would one compute the divine breath that penetrated the deadness of mere matter on the day of creation? The answer to this question is so much a foregone conclusion that we cannot help but suspect that there is a gross misunderstanding involved. Even if cybernetics should ever succeed in

designing systems that must be recognized as perfect behavioral equivalents of life or conscious subjectivity it would be arrant nonsense to say: this computer is alive or is conscious. Physics has learned long ago that it does not investigate what Is. It deals only with phenomena and not with what lies behind them. The same attitude should govern cybernetics. The question is not what life, consciousness, or self-reflection ultimately is, but: can we repeat in machines the behavioral traits of all those self-reflective systems that our universe has produced in its natural evolution? It is not impossible that the computer theorist might succeed completely. But even then, consciousness in a machine and consciousness in a human body would only be phenomenally identical. Ontologically speaking they would be as far apart as any two things can be. The reason is obvious: the natural product originated in a cosmic evolution lasting several billions of years and, unless we assume a divine spirit in the beginning no personal self-consciousness directed the production. The cybernetic system, however, would be produced in a radically abbreviated time scale and the development would be guided by other systems (humans) with a highly developed self-awareness. And finally the physical resources, as well as the methods of manufacture, would hardly bear any resemblance to the conditions under which Nature did its work.

Thus, even if there existed an absolute behavioral equivalence between the manifestations of self-awareness in a human body and in some other physical system designed by the methods of cybernetics, we would not know in the least what a human (or animal) personal ego actually is. In other words: the metaphysical concept of a "soul" does not enter into the theory of automata at all. *Ergo,* this novel undertaking is not hampered by any sort of metaphysical restriction. *It nowhere competes with meta*physics[41].

If this distinction is kept in mind, the possibility of developing automata which display all characteristics of self-reflection depends entirely on finding a formal logical criterion for self-consciousness or subjectivity which would be amenable to treatment in a calculus, and consequently in mathematics. Such a criterion is still unknown to science and would forever remain so if terms such as life, subject, and consciousness denoted only something supernatural. Without detracting from their possible metaphysical implications we shall show now that this is not the case. Our demonstration will be specifically associated with the concepts of subject and subjectivity because they have, by their logical connotations, played a greater part in epistemology than other related terms[42].

What strikes even the superficial reader of philosophical texts is that the term "subject" is used in two almost diametrically opposed senses. The texts talk about an absolute subject and an epistemological subject of our individual thought processes. The absolute subject represents ultimate Reality or Being that reflects itself. It is the fountain of Truth. It is supposed to be the origin of all cosmic order and harmony. And it is totally

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[41] W. Sluckin: *Minds and Machines*, Pelican Books, pp. 231 (1954) confronts cybernetics directly with metaphysics. Unfortunately, this is done very inexpertly, as is shown by the use of such self-contradictory terms as 'psychological metaphysics.'

[42] Kant's *Critique of Pure Reason* is perhaps an exception. Here, the term 'consciousness' plays a dominant role, but his successors, especially Hegel, turn again to 'subject.'

indifferent to the distinction between form and matter[43]. Clearly, no logic or computer theory can define this meaning of the term in any technically usable way. Even Cantor´s theory of the transfinite would fail. But the very same philosophic tradition talks about the subject and subjectivity in quite a different view when it refers to the finite empirical subject. Whereas the infinite subject represents the highest Good, finite subjects have no reality of their own. They are the source of all falsity and delusion. They represent disorder and boundless arbitrariness. Their very existence is based on the distinction between form and matter. As pure subjects they are nothing but empty form. Therefore they cannot reflect themselves in their true nature as subjects[44]. They only reflect objects, and consequently if they try to think of themselves they do so only in terms of objectivity, with a consequent semantic falsification of their self-reflective thoughts. And if human history resembles a "slaughter house", as Hegel remarks[45], this is so because this type of subject has never learned and cannot learn anything from history.

This is not exactly an impressive record. Certainly the subject empirical has nothing of the majesty and unapproachability of the subject absolute. There seems to be no reason why the former should not be imitated. Maybe in the process of doing so we might learn how to improve upon the natural product, which is by no means perfect. If it still sounds utopian to design automata, which display the behavioral traits of life, consciousness and subjectivity (and even ethical personality if Warren McCulloch[46] is right), our present disability is due to the fact that we have not yet developed a logic, and a corresponding mathematical procedure, which can demonstrate that these terms, and others related to them, have a precise rational and computable core. What gives them a mystical and irrational flavor is our previous incapacity to connect them with categories which belong to a strict formalism. That a datum of experience is way beyond the present scope of logic and mathematics does not necessarily give it metaphysical dignity.

But what is an individual subject, and what is general subjectivity as the medium that connects different egos ? The ground is much better prepared for a fruitful answer than most scientists realize. So far we have only listed two contributions. We possess the knowledge provided by quantum mechanics, that the introduction of subjectivity into our physical picture of the external world generates a peculiar phenomenon of distribution. And we are indebted to Ross Ashby for the insight that cybernetic systems must be described in terms not designating the materiality of the system. But there is one more relevant contribution. It was made by Heinz von Foerster, and from the viewpoint of a future logic of cybernetics it is in fact the most significant one.

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[43] This motive of indifference was especially stressed by Schelling. Cf. System der Philosophie *W. W.* 111, pp. 1- 108 (1801). See also Fichte's trenchant criticism of it. *N. W. W.* III, pp. 371-389.

[44] E. Schrödinger: *What is Life?* University Press, Cambridge., pp. 90-92 (1955) significantly speaks of 'deception' with regard to the plurality of individual finite subjects. He even invokes the Veda concept of mãya.

[45] G. W. F. Hegel: Philosophie der Geschichte, Einleitung, W. W. XI, ed. H. Glockner, Fr. Frommanns Verlag, Stuttgart, p. 49 (1949) uses the term 'Schlachtbank.' Cf. also ibid., p. 31.

[46] An unavoidable conclusion from his essay "Toward some Circuitry of Ethical Robots." See Note 7.

It originated from von Foerster´s evaluation of Schrödinger´s thesis (in his monograph What is Life?) that orderly events can be produced according to two basic principles: "order-from-order" and "order-from-disorder", principles which establish two types of natural law, the dynamical and the statistical[47]. Von Foerster makes the profound observation that there is one more principle which should not be confused with Schrödinger´s order-from-disorder. He called it, order-from-noise, and announced it in his contribution to the Conference of Self-Organizing Systems in 1960[48]. He demonstrated his idea by a simple mental experiment. Cubes with surfaces magnetized perpendicular to the surface are put into a box under conditions which permit them to float under friction. All these cubes are characterized by opposite polarity of the two pairs of those three sides which join in two opposite corners. Now let undirected energy (noise) be fed into the box by the simple expedient of shaking it. If we open the box after some time an incredibly ordered structure will emerge, "which, I fancy". says von Foerster, "may pass the grade to be displayed in exhibition of surrealistic art." No order was fed into the box, just "noise"! But inside the box a principle of selection (the polarities) governed the events. "Only those components of the noise were selected which contributed to the increase of order in the system"[49].

The exemplification of the principle may be trivial to the physicist but it delights the logician, for it demonstrates the difference between order-from-disorder and order-from-noise so clearly that a logical theory can be based on it. To do so, we should return once more to Schrödinger and his two principles. The distinction he makes cannot withstand the scrutiny of the logician. He gives all example of the order-from-order principle and describes how it represents the dynamical type of law. Later, however, he takes a second look at his example and admits that it depends on our own attitude whether we assign the motion of a clock to the dynamical or to the statistical type of event. His final conclusion is "that the second attitude, which does not neglect them (statistics), is the more fundamental one"[50]. On the other hand we have to admit that lie has made an excellent case for his thesis that the "real clue to the understanding of life"[51] is the order-from-order principle. But according to his own admission this is not really a basic principle; order-from-disorder is more fundamental. If we want to develop a formal logic for self-organizing systems we cannot be satisfied with a principle which turns out to be a derivative from some other which is more general. Moreover, one gets the impression that he does not take his order-from-order principle, as exemplified by a clock quite seriously because, according to his own words, "it has to be taken with a very big grain of salt." What makes it dubious is that Max Planck's interpretation of this principle (which was adopted by Schrödinger) is a straightforward physical concept! But are we supposed to forget now that we agreed with Ross Ashby that cybernetic laws do not belong in the same class as physical laws!

It seems to us that the key to the problem is to be found in von Foerster´s principle of order-from-noise. We are going to show that it is as fundamental as the order-from-

[47] Loc. cit., p. 82.
[48] Heinz von Foerster: On Self-Organizing Systems and Their Environments, In *Self-Organizing Systems*, ed. M. C. Yovits and S. Cameron, Pergamon Press, London, pp. 31-50 (1960).
[49] Loc. cit., p. 45.
[50] Loc. cit., p. 83.
[51] Loc. cit., p. 83.

disorder concept because it involves certain new logical operations which have not yet been recognized in formal logic and which we would like to name "transjunctions."

Since the Planck-Schrödinger principle of order-from-order is not basic we shall have only two fundamental concepts: order-from-disorder and order-from-noise. This requires two comments. First: we will need a logical criterion to distinguish in a calculus between disorder and noise in the specific sense which is implied by von Foerster´s new principle. Second: we will have to reconcile the order-from-noise idea with the fact that self-organizing systems feed on negative entropy. Taking first things first we like to draw the attention of the reader to the fact that Schrödinger´s term "disorder" has already its equivalent in formal logic. He calls his disorder "statistical". But statistical laws are handled by a logic of probability. Thus probability is the logical equivalent of disorder. On the other hand it is quite obvious that the feeding of noise into von Foerster´s box did not create a logical probability situation, or more disorder. We know that exactly the opposite took place. But still we must admit that disorder and noise are closely related and the old recipe for a logical definition is *genus proximum et differentia specifica*. Consequently we ask what is, from a logical point of view, the *genus proximum* or common denominator for disorder and noise ? This question was already discussed in part I of this paper. It was shown that a probability logic resulted from a distribution of the two available values over the range of their "distance" such that if 0 = false and 1 = true these two values are spread over the range of all denumerable fractions between 0 and 1.

What noise has, logically speaking, in common with disorder is that it produces a distribution. But what is distributed must be something else. Certainly not logical values, since their spreading produces only probability. A closer look at von Foerster´s model will give us a hint. His box contains cubes with magnetized surfaces. It is trivial to state that these cubes are in some state of distribution in the box before we start shaking it. It is also trivial to note that our shaking results in a different state of distribution. So far we may admit that noise also manifests itself as an agent of distribution. But now let us look at our Cubes with the magnetized surfaces. Each individual cube may be regarded by us as a tiny logical system, the two values being north pole on the outside or north pole on the inside. *Et tertium non datur.* It goes without saying that our two values exist in their system in a non-distributed state. When the shaking begins a distribution does take place and it concerns our little two-valued systems – but not their individual values! What has happened when von Foerster's surrealistic architecture finally emerges is that without any change in their internal value structure the individual systems which represent this rigid two-valuedness have been rescued from their haphazard initial position of disorder and redistributed in a fashion such that they form a system of sorts which is composed of as many two-valued systems as there are magnetized cubes in our box.

It will be useful to have another look at the state of the box before the shaking started. The cubes were at that time in some unspecified state of disorder. But the cubes themselves represented units of order. Consequently the initial situation that existed inside the box must be described as a conjunction of order and disorder. This gives us one more hint as to the significance of von Foerster´s noise influx. The noise is something which is capable of instigating a process that absorbs lower forms of order and thereby converts a corresponding degree of disorder into a system of higher order. In other words: it is a synthesis of the order-from-order and the order-from-disorder

ideas. Having discarded Schrödinger´s simple order-from-order concept we obtain now two basic principles:

Schrödinger: order-from-disorder
von Foerster: order-from-(order-plus-disorder)

In both cases the logical equivalent of disorder is a distribution of logical terms. But what is distributed is different. Schrödinger´s principle refers to the distribution of individual values. von Foerster´s concept refers to the distribution of value-systems. In the first case the internal structure of the logical system which suffers the distribution is changed: a theory of formal certainties is transformed into a theory of probabilities. In the second case nothing of this sort happens: The distribution does not concern the elements which constitute a given system but the system itself as an inviolate entity.

This gives us two entirely different meanings of distribution and consequently of disorder. von Foerster´s distinction of disorder and noise is a profound one and opens up much deeper perspectives than his unassuming demonstration with the magnetized cubes suggests at first sight. Of course everything depends now on the question whether we will be able to define a logical operator that would represent a distribution not of values but of closed value-systems. It will not be necessary to discuss value-distribution. The corresponding logic of probability is well established and we could not add anything of special relevance. It suffices to point out that our traditional two-valued logic takes care of the ordinary order-from-order concept as well as of Schrödinger's order-from-disorder principle. A simple logical demonstration of order-from-order would occur if the *Principia Mathematica* were rewritten in terms of Sheffer´s stroke function. The undertaking might have some merits but we confess we cannot find the prospect exciting. The order-from-disorder principle enters classical logic in its more important part. It is the predicate calculus that introduces probability and makes it basically ineliminable since we know that the "objective" verifiability of the argument of a function f(x) will ultimately depend on statistical terms.

As far as the second meaning of "distribution" is concerned, which we culled from von Foerster´s order-from-noise, no recognized model exists. It is up to us to give a formal demonstration of it and to introduce the new logical operation a "transjunction" which is responsible for a logic of distributed systems. The next and the last section of our investigation will give an outline of a transjunctional formalism.

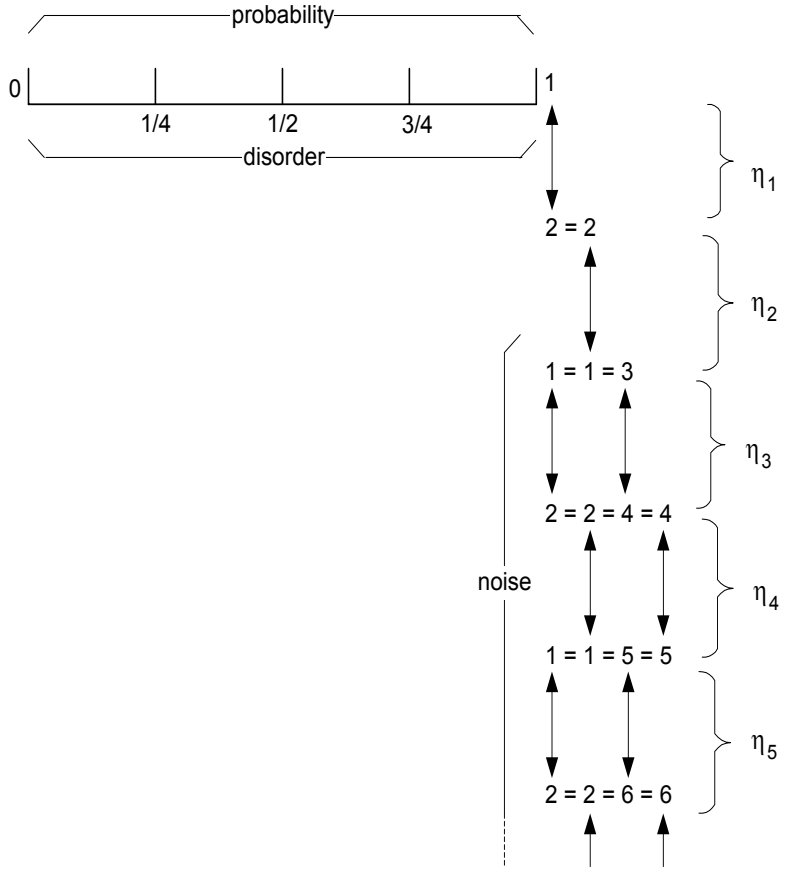
3. LOGIC WITH TRANSJUNCTIONS

If we want to distribute not logical values but systems of values our next question should be: what permits values to form a system? This system-producing factor obviously must be that which allows distribution. The demanded factor is by no means unknown; in fact its indication is rather trivial: what enables our two traditional values to form a logic is the *existence of the unary operator that we call negation* (η). Table I in Part 1 shows that a negation is nothing but a simple exchange relation between two values. This exchange relation is not in the least different from the familiar relation between the terms left and right. But if such an exchange relation establishes the basis for the formation of a logical system, then the distribution which von Foerster's principle, order-from-noise, is supposed to produce is actually a spreading of exchange relations. This extension, of course, can only be made by the introduction of additional

values. In other words, Von Foerster's principle is logically definable only if we introduce a many-valued calculus.

For our further demonstration we shall, for convenience, use the set of positive integers as members of such an exchange relation, and we shall refer to them – if they are so related – as "logical values". We also introduce the term "successor" as it is known from Peano's group of axioms for such a numerical sequence, and we stipulate that each integer or value forms an exchange relation with its successor. By doing so we obtain a linear sequence for potential classic systems of logic; or to be more precise, we locate the very same two-valued system of logic in a linear sequence of "places". We further stipulate that the designation "classic" should apply only to systems that are established by an exchange relation between a value and its – successor. For the time being we ignore possible exchange relation which may be formed by any two values where one is not the immediate successor of the other. It goes without saying that such a linear sequence of exchange relations does not yet represent a many-valued calculus, let alone the idea of a new trans-classic system of logic. Our foregoing remarks are only intended to prepare the way for a scheme that shall illustrate our two concepts of distribution and their relation to Schrödinger's "disorder" and to von Foerster's "noise". We indicate distribution of values by an ordinary straight line. Along this line negation is indicated by 0. For the distribution of systems, negation is represented by any positive integer m where m > 1. Both distribution patterns have in common the value "1". In its horizontal relation "1" should be interpreted as true. In its vertical reference as positive or irreflexive.

Table III



The vertical column of value-systems is written twice. On the left, only the integers "1" and "2" are used. On the right, "1" is identified in its second occurrence with "3", from there on subsequent odd numbers are always used whenever the positive value turns up; even numbers indicate the reoccurrence of places for the negative value. This parallel arrangement helps to point out that "3", "4", "5"… do not represent values in their own right but are, for the time being at least, solely chosen for the task of identifying the place where a

specific classic value is located (if it is part of a system which has suffered distribution). It is important to signify this by a unique number for each place because the very same system, and with it its values, acquires different functional properties in different stages of distribution. Furthermore, this method or a similar one is required if we want a notational opportunity to introduce a discrete series of η-operators. But it should not be forgotten that the sole object of distribution is the same classic system, 0 - 1, which provides, us with the logical frame for a theory of probability (as indicated in the horizontal part of our diagram).

The reader is reminded that Table III serves only as an illustration of what is meant if we distinguish two different forms of distribution in logic. We have not yet shown how a new theory of calculi for system distribution may originate from von Foerster's principle order-from-(order-plus-disorder). So far we only know that a type of distribution that does not produce probability might be effected by a sequence of negational operators ($\eta_{1\ldots k}$) such that any m-valued position might be reached by the use of the operators $\eta_1 \ldots \eta_{m-1}$ as the matrix below Table IV shows:

Table IV

	η_i
i	i + 1
i + 1	i

If we state that a many-valued system is a distributive order for the classic two-valued system we shall have to qualify this proposition. The avowed purpose of our undertaking is, of course, to make Von Foerster´s "noise" logically treatable. In other words, the traditional system of logic will appear in our trans-classic order in a form in which it possesses values that transcend its structural frame and therefore represent "noise" from the viewpoint of a strictly dichotomous theory of thought. We shall see later oil that this gives the value concept a double meaning in higher systems of logic. This ambiguity reduces its importance considerably. It will be seen in due course that what is really distributed in trans-classic structures of logic are not so much value-systems as a new logical unit which serves as basis for systematic value constellations. But the interpretation of many-valuedness as system-distribution will serve us to It should only be remembered that the concept of value Permits only a very one-sided evaluation of trans-classic logic.

We shall now present our approach to the problem of system distribution and show that this yields a new type of logic which might be the answer to some problems of cybernetics. This theory will permit a positive operational definition of "subject" and introduces a new logical unit which complements the value concept. We take our start from the familiar table of the 16 two-valued, binary truth functions and demonstrate our departure by using as an example inclusive disjunction, as shown in Table V:

Table V *)

p	q	p ∨ q
1	1	1
1	2	1
2	1	1
2	2	2

Now we remind ourselves that we intend to develop a logic capable of defining subjectivity in logical contraposition, to everything that designates mere objects and objectivity. If we examine Table V from this viewpoint, it occurs to us that the variables "p", as well as "q", represent objective data. In the usual interpretation of the propositional calculus they are identified as unanalyzed statements. But statements are clearly objects and carry an objective meaning. The same must be said – although in a lesser sense – of the values that are attached to the variables: they too have, in this two-valued context, an objective meaning. They designate whether something is or is not. In our special case the values determine two mutually exclusive properties that a statement might have. There might be some doubt about the symbol "∨" which is supposed to denote disjunction. One might argue that this is a subjective concept and as such not really designating objectivity. But one might also say that it refers to a psychological act performed by our brain and in this case "∨" should be classed with the other symbols contained in our table. In fact, we shall do so because we wish to be cautious and because we intend to eliminate from Table V everything that may semantically refer to the objective context and meaning of Reality.

It seems there is nothing left to represent the subject in this context: we seem to have obliterated the whole table. But this is not quite so, for something else is offered by Table V; it also represents, apart from variables, values and operations, three abstract patterns of *possible* value occupancy. These and only these we shall retain. To claim that these empty patterns by themselves designate objective data and have a concrete semantical meaning relative to an objective world would be rather difficult. So we shall accept patterns of possible value occupancy as the basic elements of a new logic which should be capable of defining subjectivity. We obtain more patterns of this type if we extend our procedure of getting rid of symbols with reference to objectivity to all 16 truth-functions of classic logic. In order to distinguish these patterns we shall use the two symbols ∗ and □ which, we stipulate, shall have no *logical meaning*. They only indicate that if a meaningful logical sign occupies a ∗ place in a given pattern it cannot also occupy a place which is marked by □ and *vice versa*. Using these two marks we obtain, from two-valued logic, eight abstract patterns:

*) Note (evgo) :
in classical logic the disjunction is given as in the table, where " 0 " symbolizesthe negation and " 1 " the affirmation, respectively. Günther uses for the affirmation the value " 1 " and for the negation the values " 2 ", " 3 ", and so on.

		classic	Günther
a	b	a ∨ b	a ∨ b
0	0	0	2
0	1	1	1
1	0	1	1
1	1	1	1

Table VIa

1	2	3	4	5	6	7	8
*	*	*	*	*	*	*	*
*	*	□	□	*	□	*	□
*	□	*	□	*	*	□	□
□	□	□	□	*	*	*	*

Since each mark – for the time being – holds the place for two values, these patterns yield, if so used, our familiar 16 two-valued truth-functions. We have numbered the patterns for easy identification; no other significance is attached to the numbers.

It is obvious, however, that Table VIa does not represent all possible abstract patterns for occupancy by meaningful logical symbols. And since the patterns by themselves are completely indifferent to the question whether there are enough such symbols to fill additional patterns there is no objection to introducing two more meaningless marks in order to give us an opportunity to complete the table of. all possible four-place patterns. (If we intend to regard these patterns – without prejudice to value occupancy – as the basic elements or units of a new system of logic we cannot afford to select arbitrarily just eight out of a larger number).

In order to complete our table we shall use the additional marks ▲ and •, to which also no logical significance is attached, in order to indicate possible value-occupancy by more than two values. We then obtain the rest of the patterns as shown in Table VIb:

Table VIb

9	10	11	12	13	14	15
*	*	*	*	*	*	*
▲	*	▲	□	▲	□	▲
*	▲	□	▲	▲	▲	•
□	□	□	□	□	*	□

Thus a table displaying all possible patterns has precisely 15 entries, a number which can be derived from Stirling´s numbers of the second kind.[+)] It will be noted that some rule of placing the marks has been followed: for instance, starting the columns always with ∗. This is more or less a matter of convenience and we might as well, write the pattern No. 14 with, e.g., the following order of marks: ∗ ▲ □ ∗. This is for the time being quite irrelevant. We are at this moment only concerned with the abstract patterns of potential value-occupancy and from this view-point both arrangements, ∗ □ ▲ ∗ and ∗ ▲ □ ∗, represent the same pattern. The case, of course, is different when we replace the

[+)] See note [69] and Formula (28) on page 50

meaningless marks by actual values with specific logical significance. The simplest case is pattern No. 5: * * * * . But even this pattern can assume an infinite number of meanings. In two-valued logic it has just two aspects of theoretical relevance expressed by the value sequences T T T T and F F F F for true and false. These aspects would grow to three in a three-valued logic and to infinity if we permitted the number of values to increase beyond any limit.

However, no matter what the actual value-occupancy of a pattern may be, the identity of the abstract pattern or structure, and therefore the continuity of meaning, would always be retained. This indicates that the fifteen patterns of the Tables VIa and VIb, although composed of signs without logical significance, represent some sort of meaningful order. Their full meaning still escapes us, but this much may be said now: no matter how comprehensive the logical systems we construct and no matter how many values we care to introduce, these patterns and *nothing else* will be the eternally recurring structural units of trans-classic systems. Our values may change but these fifteen units will persist.

In order to stress the logical significance of these patterns, and to point out that they, and not their actual value occupancies, represent invariants in any logic we shall give them a special name. These patterns will be called "morphograms", since each of them represents an individual structure or Gestalt (μορφή). And if we regard a logic not from the viewpoint of values but of morphograms we shall refer to it as a "morphogrammatic" system.

If we look from this angle at classic logic we see that we should more properly speak of it as a system of values. As a morphogrammatic order it is incomplete, for only the eight patterns of Table IVa are utilized. It is, therefore, impossible to say that its logical units are *the* morphograms. The tradition rightly considers the classic system as a value theory. The values are its formal units. The actually employed morphograms assume only a secondary role in this context. In more comprehensive systems the situation is reversed. The reliance on the value concept makes the interpretation of trans-classic calculi so difficult that many logicians refuse to recognize them as the potential base of a new logic[53]. They claim that the two-valued system (with the theories of probability and modality) represents the only genuine formal theory of thinking.

We shall now look at the situation from the morphogrammatic stand-point. As a system of morphograms the classic logic is incomplete. It employs only those eight patterns that are, if occupied by the two classic values, logical equivalents of the objective component of Reality. This is quite as it should be. This theory was developed for the very purpose of describing the world in radically objective terms with all subjective traits rigidly excluded. The subject was traditionally considered the metaphysical source of all arbitrariness, error, and fraud: objects never lie but the subject may. As long as this prejudice was cultivated it was, of course, absurd to try to give a formal logical definition of what is meant if we use words like "subject" or "subjectivity." On the other hand, if we look at the problem without any of the traditional prejudice and rid

[53] B. von Freytag - Löringhoff: Über das System der Modi des Syllogismus, *Zeitschr. f. Philos. Forsch*. IV, pp. 235-256 (1949). Same author*: Logik; Ihr System und ihr Verhältnis zur Logistik*, Kohlhammer, Stuttgart (1955). Also H. A. Schmidt: Mathematische Gesetze der Logik I, Springer, Berlin - Göttingen - Heidelberg, p. 124s (1960).

ourselves of the associations of irrationality that commonly accompany these two terms we shall find that a very precise logical meaning can be connected with them. Since Table VIb is excluded from a logic that describes the objective character of the world it can, if interpreted in a morphogrammatic logic, not refer to objectivity. It can consequently only refer to the part that the subject plays in a logic which does not suffer under the restrictions which an old ontological tradition has imposed on our theories of rational thought.

However, there is some grain of truth in the tradition. If we use a term borrowed from information theory we might say that a formal logic is required to be a "noiseless" system. The introduction of subjectivity into it would make it very noisy. Since this cannot be tolerated in classic logic, but is demanded in cybernetics, we are required to develop a more comprehensive theory which is not hampered by the morphogrammatic restrictions of two-valued logic. Subjectivity is a logical theme beyond the boundaries of our traditional ontological concept of Reality. We repeat again: the tradition equates Reality and objectivity and excludes the subject from it. This has led, during the long history of metaphysics, to the identification of subjectivity or consciousness with the concept of a transcendental soul which has arrived from Beyond and is but a guest in this Universe. But there is also a different concept represented by primitive religion and pointedly worded by an American Indian tribe, the Algonquins. They define a subject as "that which has cast itself adrift." With these ideas in mind we shall try to interpret Table VIb .

Since it will make our task easier, we repeat the Tables VIa and VIb but this time not as abstract morphograms. We shall present them as occupied by values. Since we will have to introduce four values, "1" and "2" shall represent the traditional values; and, since we only discuss four-place sequences for the time being, we stipulate that they may retain their full ontologic significance. "3" and "4" will be the additional values which the filling out of Table VIII requires. The value sequences thus obtained may be referred to as the "standard forms" of the morphograms. This, however, is a mere convention since any other choice of values would represent the patterns equally well.

Table VII

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
1	1	1	1	1	1	1	1
1	1	2	2	1	2	1	2
1	2	1	2	1	1	2	2
2	2	2	2	1	1	1	1

A logic which is two-valued and uses only these eight morphograms is severely restricted in its value occupancy. There is just one non-standard form which is obtained by traditional negation.

We add now the standard forms of the additional morphograms in Table VIII:

Table VIII

[9]	[10]	[11]	[12]	[13]	[14]	[15]
1	1	1	1	1	1	1
3	1	3	2	3	2	3
1	3	2	3	3	3	4
2	2	2	2	2	1	2

If a logic uses the morphograms of Table VIII, with [15] excluded, a three-"valued" system is required. The number of nonstandard value occupancies increases then to five. But only a four-"valued" logic is morphogrammatically complete. It becomes so by adding pattern [15]. Twenty-three non-standard value occupancies are available in this case. If more value-occupancies are desired, systems with more values have to be chosen. And there is, of course, no limit how far we want to go.

But this raises the question: what is meant if we use the term "value" in systems which employ Table VIII? The answer will lead us straight to the problem how subjectivity may be defined in a system of formal logic. To make our point we will take the standard forms of the morphograms [1], [4] and [13] and consider them as functions resulting from – the traditional variables "p" and "q" as is done for [1] and [2] in the truth-tables or in matrices of the propositional calculus. We now only add [13] and put all of them together, for demonstration purpose, in another Table IX. As classic values we shall use "P" and "N" for "positive" and "negative" and for the additional value required by morphogram [13] the number "3 " as in the preceding Table IX:

Table IX

p	q	[1]	[4]	•	[13]
P	P	P	P	•	P
P	N	P	N	•	3
N	P	P	N	•	3
N	N	N	N	•	N

The additional dotted line shall indicate that [13] does not properly belong to this Table. In this arrangement "p" and "q" are supposed to represent any objective system that offers an (exhaustive) choice between two values. We notice that [1] and [4] have something in common. Where two values are proffered, as is the case in the second and third position of the value-sequence, the two classic functions *accept the choice.* Between them they take what is available in terms of values. They differ only insofar as the function which is carried by morphogram [1] prefers the lower value and the one represented by [4] picks the higher one. It is obvious that the function carried by [13] is not of this type. Where there is a choice of values offered by "p" and "q" the *very choice is rejected.* This is the only formal logical meaning any additional value beyond "P" and "N" can have. Any value that does not accept the proffered choice is a rejection value: it transcends the objective (two-valued) system in which it occurs. In analogy to disjunction and conjunction we shall therefore call a morphogram which requires more

than two values for its filling a "transjunctional" pattern; an operation performed with it a "transjunction."

It stands to reason that the rejection of a value choice does not have to be total (but undifferentiated) as in [13]. There are also the possibilities arising from partial rejection: the morphograms [9] to [12] represent them in all their variations. And there is also a radical rejection [15] which differentiates the total refusal to accept the alternative of two values. Finally we have to acknowledge that equivalence too may have its transjunctional extension. It should be noted that from the morphogrammatic point of view the transjunctional equivalence cannot assume total form, for if we wrote in [14] the value sequence 1 3 3 1 we would only repeat, with different value occupancy, the morphogram [8].

So far we have interpreted the value occupancies which were effected by "3" and "4" in Table VIII from a purely formal standpoint. We characterized them as rejections of a pair of alternative values. But such abstract characterization does not provide us with an ontological interpretation of these value sequences. In other words, we also want to know the semantic meaning of the transjunctional morphograms. A clue was given in this direction when we referred to the Algonquian definition of a soul as that which has cast itself adrift. This means something that does not anymore belong to the ordered context of things that surround us and that make up the physical reality of our Universe. On the other hand, since the dawn of History, whoever used a term like "subject" (or some equivalent of it) was capable of conceiving anything else but a purely negative thought. He tried to I conceive a mysterious x that defied description in terms of any predicate that was applicable to some objective content of the Universe. We find the classic expression of this ontological attitude in one of the oldest religious texts, in the Brihadārnyaka-Upanishad, where it is tersely said that the ālman (the soul) can only be described by the terms *"neti neli"*. Translated from the Sanskrit it means: not this and not that. The sentences preceding the neti-term in the Sanskrit text make it quite clear that from any duality of (contradictory) terms neither is applicable[54]. But this is exactly what morphogram [13] indicates. Where there is a choice of two alternative values both are rejected. It is impossible for us to connect any other formal logical meaning with terms like "subject", "subjectivity" or "consciousness" but rejection of an alternative that is total as the (exclusive) disjunction between true and false. For this very reason the morphograms [9] - [15] express as logical structures what we intend to say if we make statements which include references to the non-objective side of Reality.

It should be clearly understood that the issue for the cyberneticist is not whether there is an occult essence in the Universe which is called "subjectivity" and whether our definitions and methods conform to it or whether such metaphysical quale does not exist. The situation is exactly the reverse. Our logic does not depend on the fact that there are such more or less mysterious phenomena as subjects and subjective processes in the Universe, the secret properties of which we have first to discover so that afterwards we can talk about them and form categories and concepts for their empirical description. This is hopeless! Subjectivity can only be experienced by personal introspection. But the latter is not communicable in scientific terms and will never be. The procedure we propose to employ is not interested at all in what our private insight

[54] Brihadaranyaka - Upanishad, IV, 2, 4 and IV, 5, 15.

might tell us about our innermost subjective life – this is the business of artists and theologians – it only stipulates the acceptance of the morphograms [9] - [15] in the logic of cybernetics.

In the future it will be unavoidable to talk about subjective functions in cybernetic theory. This will be the case when we discuss systems that have an actual center of reflection or which at least behave in a way that such conclusion is forced upon us. Under the circumstances it will be of paramount importance to have a general agreement about what we mean if we refer to the subjectivity or the subjective functions of a given system. We propose as basis for a general consensus the following statement: *if a cyberneticist states that an observed system shows the behavioral traits of subjectivity he does so with the strict understanding that he means only that the observed events show partly or wholly the logical structure of transjunction.* There is nothing vague and arbitrary in this use of the term "subjectivity." It implies clearly that we are not interested in what a subject metaphysically is – even if – this question might have some meaning – but what definitions we intend to use if we try to discourse about subjectivity in a communicable scientific manner.

However, since Table VIII presents a certain richness of transjunctional structure (when compared with the simple duality of disjunction and conjunction), some explanatory remarks are in order. The variety of morphograms refers to the fact that we cannot talk about the subjective component of Reality unless we distinguish three different states of it. It may be

a) a property of something else
b) a personal identity structure, called a subject
c) a self-reference of (b).

Everybody is familiar with these three aspects of subjectivity. The first is commonly called a thought; the second, an "objective" subject or person; the last, self-awareness or self-consciousness. These three distinctions correspond to the three varieties of rejection of a two-valued alternative which Table IV demonstrates:

a) partial rejection : morphograms [9] - [12] and [14]
b) total, undifferentiated, rejection : morphogram [13]
c) total, differentiated, rejection : morphogram [15]

A thought is always a thought of something. This always implies a partial refusal of identification of (subjective) form and (objective) content. This fact has been noted time and again in the history of philosophic logic, but the theory of logical calculi has so far neglected to make use of it. Any content of a thought is, as such, strictly objective; it consequently obeys the laws of two-valued logic. It follows that for the content the classic alternative of two mutually exclusive values has to be accepted. On the other hand, the form of a thought, relative to its content, is always subjective. It therefore rejects the alternative. In conformity with this situation the morphograms [9] - [12] and [14] always carry, in the second and third rows of Table IV, both an acceptance and a rejection value. Together, they represent all possible modes of acceptance and rejection.

A personal identity structure or subject is logically characterized by the fact that not even a partial identification with anything objective (two-valued) is tolerated. The subject, qua subject, is in total contraposition to the whole of the Universe as its logical

and epistemological object. It has "cast itself adrift." Morphogram [13] corresponds to this situation. On the other hand it is obvious that the actual refusal of identification with anything objective that is implied by [13] does not provide us with a logical pattern which would denote the potential capacity of self-awareness of subjectivity. The last discussed morphogram indicates awareness of something (which may be its objective content) but no reflection of its state of being aware. The abstract pattern of this situation is furnished by morphogram [15] which incorporates four different values. The two center values have in common that they reject the alternative of "1" and "2" But in one case the rejection is effective in a three-valued system. In the other the rejection has an iterated character. This function designates self-consciousness and the latter is, indeed, an iteration of consciousness. The morphograms [1] – [8] require for their application only a two-valued system of logic. For the patterns [9] - [13] and [14] a three-valued order is necessary. But [15] cannot be used unless a four-valued logic is accepted as basis for a theory about all subjective components of Reality.

By introducing the morphograms [9] - [15] into his logic the cyberneticist becomes able to speak in a finite and non-ambiguous way about subjectivity in self-organizing, and therefore self-reflecting systems. Warren S. McCulloch has stated that if somebody can "specify in a finite and unambiguous way what a brain does with information, then we can design a machine to do it"[55]. The above described logical situation does not yet meet McCulloch's demand, but we think it indicates at least the formal logical structures any sort of consciousness and self-consciousness must use in order to become aware of and use information that infiltrates the brain. By referring to the morphograms we are in a position to state in a finite, non-ambiguous, and computable way what we mean if we say a system has subjective properties or represents a subject or has self-awareness. The precise meaning of such a statement is simple *that the behavioral properties of the system in question display a logical structure that includes rejection values.* And the individual morphograms which come into play will indicate precisely which of the three described varieties of subjective behavior we are referring to.

The introduction of the fifteen morphograms as the basic logical units of a trans-classic system of logic has far-reaching consequences. Such units would have hardly more than decorative significance unless there exists a specific operator able to handle them and to transform one morphogram directly into another. Negation is not capable of doing this as long as we adhere to the classic concept of negation. It is traditionally a reversible exchange relation between two values. It follows that by negating values we only change the value occupancy of a morphogram, not the morphogram itself; no matter how many negations are used, the abstract pattern of value occupancy remains always the same[56].

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[55] W. S. McCulloch: Mysterium Iniquitatis of Sinful Man Aspiring into the Place of God. *Scientific Monthly*, 80: No. 1, pp. 35-39 (1955).

[56] The situation would, of course, be different if we introduced negators like

N	
1	3
2	3
3	1

or

N´	
1	2
2	1
3	1

footnote continues on the next page

However, there is another way to look at the matter. Kant and his successors in the field of transcendental logic: Fichte, Hegel, Schelling, discovered it. Its significance for a formal calculus of logic has so far not been understood. This was partly the fault of its initiators because they insisted that it could not be formalized. These philosophers introduced an operation into their systems of metaphysical logic which they called: "setzen". Although the term is untranslatable – it could at best be rendered as "objectivate" – its meaning is quite clear. Every concept we use, so goes the theory, has to be treated as an objective reflection of itself. Only as such does it acquire significance. The principle of identity cannot be stated as "A" but as "A = A" (Leibniz)[57]. In order to emphasize the point that any concept we use behaves as a mirror image of itself Fichte introduces an interesting notation[58]. He does not write A = A like Leibniz but $\frac{B}{B}$ and $\frac{B}{S}$, where the horizontal line is meant to indicate the plane of reflection. For an iterated reflection[59] he extends his notation to $\frac{\frac{B}{B}}{B}$. He further produces formulas of reflection[60] like $I = \frac{S}{O} \infty$, where "I" stands for identity, "S" for subject and "O" for object. But he gives no formation rules. The attempt was let down by the ineptness of the technique he used, but it showed very clearly that Fichte was groping for a specific calculus of reflection. Hegel later added the idea that not only terms but also the operation commonly called "negation" should be treated as a reflection of itself. His *Logik* is an attempt to implement this program. We shall use these ideas of Leibniz, Fichte, and Hegel and show that they point the way to a general logical operator for reflection which satisfies the demand for a formal transformation of one morphogram into another regardless of their value occupancy.

For the time being we shall retain Fichte´s notation; but instead of the letters A and B we shall use our nondescript marks: ∗, □, ▲, and • because we intend to generalize the concept of self-reflection to the point where it includes our morphograms. By placing the appropriate marks above the plane of reflection and their mirror images below we obtain the following arrangement of morphogrammatic patterns. (We shall, however, not use Fichte´s notation for iterated reflection: $\frac{\frac{A}{A}}{A}$ since a formal logic takes care of this phenomenon with other methods). See "Fichte-Table" X for shapes. The one-place reflection (a star and its mirror-image) is easily recognized as the classic identity principle which Leibniz wrote A = A. This star represents the only morphogram which

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Although these negations have been used by Łukasiewicz and Reichenbach we cannot recognize them as basic principles of negation. Their application was dictated by material viewpoints. In Łukasiewicz' case the aim. was to gain an intuitive understanding of three-valued logic. Reichenbach was moved by specific demands of quantum-mechanics.

[57] G. Leibniz: *Nouveaux Essays sur Pentendement humain*, IV, 2, Section 1. See also Fichte's remarks on Schelling's transcendental idealism. N.W.W., Ed., J. H. Fichte, III, pp. 368-389.

[58] *N.N.W.*, ed. J. H. Fichte, 1, p. 160 ss. 'B' stands for 'Bild' and 'S' for 'Sein'.

[59] *N.N.W.*, ed. J. H. Fichte, 1, p. 419.

[60] *N.N.W.*, ed. J. H. Fichte, 111, p. 381.

could be ascribed to a so-called one-valued logic. The fifteen examples of four-place reflection are provided by the morphograms of a two-valued logic. If we were dealing with a three-valued logic our table would have to show nine-place reflections. Generally: for any m-valued system the reflection would have m^2 places.

It is worth mentioning that a generalized concept of reflection that plays an important part in Fichte´s and Hegel´s logic interprets negation as a specific form of reflection. If we wrote negation

$$\frac{*}{\square}$$

instead of using the conventional table form one can easily see why the process of negation was interpreted in this manner. However, we do not want to delve into this aspect of reflection. It is sufficient to say that reflection in a larger sense may utilize any number of places. In this more general theory all Stirling numbers play their proper parts. Be that as it may, this investigation considers only morphogrammatic reflections of m-valued systems with m^2 places. If $m > 2$ it will be advisable not to speak of morphograms alone but also morphogrammatic compounds. The distinction is essential. With increasing m the number of morphogrammatic compounds increases too. But the number of morphograms as basic units of formal logic remains the same no matter how large m is. The hierarchy of all m-valued orders represents a "quindecimal" system of morphogrammatic reflection.

Table_X

	1	2	3	5	6	8	9	10	13	14	15
	*	*	*	*	*	*	*	*	*	*	*
	*	*	□	*	□	□	▲	*	▲	▲	□
	*	□	*	*	*	□	*	▲	▲	●	▲
*	□	□	□	*	*	*	□	□	□	□	*
*	□	□	□	*	*	*	□	□	□	□	*
	*	□	*	*	*	□	*	▲	▲	●	▲
	*	*	□	*	□	□	▲	*	▲	▲	□
	*	*	*	*	*	*	*	*	*	*	*
	4	2	3	5	7	8	12	11	13	14	15

Fichte´s notation of a horizontal line as a symbol of reflection is not very practical. We shall replace it by the sign "ℜ" which we will call a reflector. A reflector is an operator that produces the reflection of a given morphogrammatic pattern; be that a single morphogram, a morphogrammatic compound or a morphogrammatic sub-unit of such a compound. This means that ℜ, if so indicated, may operate one, two, three or any number of morphograms which make up a larger compound.

Since, however, morphograms do not occur as empty structural patterns in logic, but are always occupied by values, the symbol η ... for negation will, of course, be retained. If

applied it will always carry the appropriate suffix indicating the specific values which are operated. If there is only one suffix and the suffix is an integer it is indicated that the negation represents an exchange relation between two values which are not separated by a third. All other cases will be treated as composites of such elementary exchange relations. Their composition will be indicated by adding to η the suffixes of the negations which contributed to the given constellation of values. Our sequence of elementary tables looks as follows:

	η_1
1	2
2	1

	η_2
2	3
3	2

	η_3
3	4
4	3

if $1 \leq i < m$ negation is defined

$$\eta_1 (1,2,\ldots i, i+1 \ldots m) \rightarrow (1,2,\ldots i+1, i, \ldots m)$$

for all m-valued systems. Thus the table of negations of a three-valued logic is represented by Table XI.

Table XI

	η_1	η_2	$\eta_{2.1}$	$\eta_{1.2}$	$\eta_{1.2.1}$ or $\eta_{2.1.2}$
1	2	1	2	3	3
2	1	3	3	1	2
3	3	2	1	2	1

$\eta_{2.1}$ is defined by

$$\eta_{2.1} =_{Def} \eta_1 \cdot \eta_2$$

In words: operate η_1 on the result of the operator η_2. Since the order of the suffixes is somewhat awkward and $\eta_{2.1}$ produces the mirror-image of η_2 we may as well use the reflector "ℜ" and write $\eta_{2.R}$ and $\eta_{1.R}$ It is worthwhile to note that these negations are not commutative:

$$\eta_{1.R} \neq \eta_{2.R}$$

If the whole standard sequence of values is reversed we omit all numerical suffixes and add only ... R. Thus we may write on the basis of Table_XI:

$$\eta_R =_{Def} \eta_{1.2.1} = \eta_{2.1.2}$$

This notation may be advantageous if we have a long row of suffixes for η... . The reflector "ℜ" may be, according to Table_X, added to non-negated (standard) value sequences or to negations as it is convenient.

In order to indicate (in the case of Table_XI and also in the .case of tables of negation with a large number of values) that "ℜ" applies to constellations of, individual values and not of morphogrammatic structures, the operator of reflection will always be written in index form after "η". If the original order of values is that of the normal sequence of integers the negational reflexion "η_R" shall have no index unless it is not certain to

which value system the operation applies. If we want to point out, for instance, that "η_R" does not signify the sequence 3-2-1 but 5-4-3-2-1, we add the number of values as subscript to $\mathfrak{R}$: η_{R5}. However, this will not be necessary if the morphogrammatic compounds carry the index of the value-system to which they belong. If "$\mathfrak{R}$" operates on a morphogram, it is placed before it.

The reflective properties of the morphograms can now be written with a provisional notation (if we assume that they have standard form):

$$\mathfrak{R}[1] = \eta_1[4] \qquad \mathfrak{R}[4] = \eta_1[1]$$
$$\mathfrak{R}[9] = \eta_1[12] \qquad \mathfrak{R}[12] = \eta_1[9]$$
$$\mathfrak{R}[10] = \eta_1[11] \qquad \mathfrak{R}[11] = \eta_1[10]$$

$$\mathfrak{R}[6] = [7] \qquad \mathfrak{R}[7] = [6]$$

$$\mathfrak{R}[2] = \eta_1[2] \qquad \mathfrak{R}[3] = \eta_1[3]$$
$$\mathfrak{R}[13] = \eta_1[13] \qquad \mathfrak{R}[15] = \eta_{1.3}[15]$$
$$\mathfrak{R}[14] = \eta_1[14]$$

$$\mathfrak{R}[5] = [5] \qquad \mathfrak{R}[8] = [8]$$

We notice that the reflection-operator $\mathfrak{R}$ affects different morphograms in different ways. The first group of our "formulae" shows that the law of duality holds not only for disjunction and conjunction but also for all forms of partial transjunction. The second group, which consists of only one line, shows the reflective symmetry between the conditional and its inverse. From the third group we learn that for morphograms [2], [3], [13], [14] and [15] the $\mathfrak{R}$-operator is equivalent to various forms of negation. And the last group shows that due to their symmetrical structure neither morphogram [5] nor [8] is affected by the operator of reflection.

These limitations of the $\mathfrak{R}$-operator show clearly that, even if we could use transjunction in a two-valued logic, which we cannot, the classic formalism does not provide us with a satisfactory theory of reflection. In a physical universe which is adequately described by a two-valued logic some phenomena show reflective properties and others do not. But this situation is unacceptable for a logical theory which is to include the subject. Fichte has pointed out repeatedly that subjectivity of the subject means nothing but perfect transparency ("Durchsichtigkeit")[61]. This does not mean, of course, that a subject or consciousness is, at all times and in every respect, completely transparent to itself: there are opaque spots in our subjectivity, as everybody knows from his own experiences. There was no need for Fichte to point that out, for Kant had already established what was meant by this term. One of the most important passages in the *Critique of Pure Reason* reads (in translation): "That: *I think* (I am aware of) must be capable of accompanying all my representations …"[62]. In other words, the point is not that the self-transparency of the subject must be present in every moment and with regard to every content of the reflexive mechanism but that it is on principle always

[61] *N.N.W.*, ed. J. H. Fichte, II, p. 43; *Was ist die Ichheit am Ich ?* Es ist die absolute Durchsichtigkeit.

[62] B 131 'Das *Ich denke* muss alle meine Vorstellungen begleiten können…'

capable of doing so. It is impossible for any subject to be aware of something, and to be at the same time constitutionally incapable of acknowledging it as its own.

This is in fact a maxim that has been incorporated in our scientific concepts for a long time, though couched in a different terminology. Physicists would reject something to be physically real if that something could never be observed, either directly or indirectly and could never be the possible object for any sort of thought. A "subjective" awareness which faced and reflected a "world" which contained such mythical objects would indeed be partly opaque. A subject is an all or nothing proposition. In other words: a partly opaque subjectivity could not exist at all. To understand this fully, one has to remember the distinction between the operation of reflection and what is reflected. It corresponds roughly to the difference between consciousness and what one is conscious of (commonly called its content). There are, of course, always gaps and discontinuities in the content of our consciousness. The reflexive mechanism of our body registers at any given moment a practically unlimited number of impressions from the external world we are actually not aware of. That means that any consciousness is, with regard to its content, highly fragmentary and discontinuous. But what cannot be fragmentary and full of gaps is the process of reflection itself. A simple example may make this clear. If we say: "one, two, three, four …" we are dimly aware of a nervous activity which we call "counting". This is at the very moment the actual content of our reflection. And nobody will deny that this content may be discontinuous and fragmentary in an indefinitely large number of ways. We may stop counting and we may resume again. A small child trying to learn it may skip numbers. Our attention may be diverted while our lips continue to articulate numerical terms or we may finally give up from sheer exhaustion. But no same person would seriously assert that the law of conscious reflection which manifested itself in this activity could be fragmentary or break down all of a sudden. The law which we applied was the principle of numerical induction; and although nobody has ever counted up to 10^{1000}, or ever will, we know perfectly well that it would be the height of absurdity to assume that our law might stop being valid at the quoted number and start working again at 10^{10000}. We know this with absolute certainty because we are aware of the fact that the principle of induction is nothing but an expression of the reflective procedure our consciousness employs in order to become aware of a sequence of numbers. The breaking down of the law even for one single number out of an infinity would mean there is no numerical consciousness at all! This is what we intended to say with the statement that a system of self-reflection cannot be partially opaque: its transparency is complete. And when Fichte uses this term he always means that consciousness has a knowledge of itself that it does not have to acquire empirically. It possesses it by dint of its own nature of "total reflection" (Hegel).

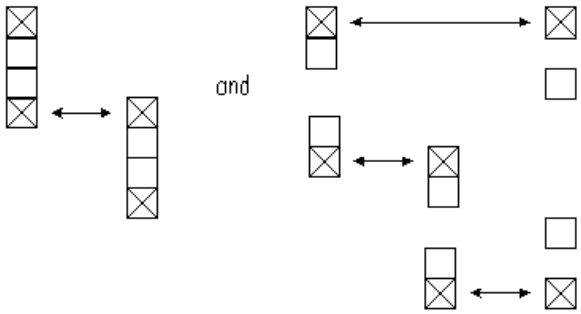
These considerations should make clear why a logical system that displays only partial reflexivity is an insufficient theoretical basis for a theory of consciousness. Even if we add the transjunctional morphograms to the classic array we discover that the reflections produced by the $\mathfrak{R}$-operator on four-place patterns are fragmentary. If we are restricted to four places it is non-sensical to assume that morphogram [13] could be a reflection of [5]. But a theory of total reflection would demand this very thing! On the other hand, such a demand can be met if we proceed from the single morphograms that the traditional logic uses to compounds of morphogrammatical structures.

There are still many competent thinkers who object to the proposal of a trans-classic logic (which would include the traditional two-valued theory) as a new organ of philosophy as well as of science, so the step into this novel realm should not be taken lightly. On the other hand we are forced to make it. The classic system is morphogrammtically incomplete; even if we could add the missing patterns (treating the additional values as merely some trans-logical "noise" of irrational origin and as indices of probability) the situation would not improve. As a system of reflection the revised theory would still be incomplete. The operator "$\mathfrak{R}$" is not capable of deploying its possibilities with individual morphograms.

4. MORPHOGRAMMATIC COMPOUNDS IN M-VALUED SYSTEMS

In order to establish logical continuity in compounds of morphograms, the individual patterns have to be joined in such a way that all joinable places are actually connected with each other. These places are the top and bottom value occupancies of each morphogram. If we look at the two arrangements:

Table XII



we see that a compound of only two patterns does not produce a system of morphograms. Both patterns have joinable places, indicated by x, which are not joined. The compound on the right side, however, represents a system. All joinable places of value occupancy are connected. It should also be noted that the pseudo-compound on the left side offers only seven places of value occupancy. This is too much for two values and not enough for three.

It seems at first to be trivial to point out that the value occupancies in the joinable places must always be identical, but we shall see later that this has in fact far-reaching consequences for the theory of the $\mathfrak{R}$-operator. The morphogrammatic arrangement on the right side provides the nine places for value-occupation which are required in a three-valued logic. But whereas the traditional theories of many-valuedness, such as those of Post, Łukasiewicz, Wajsberg, and Slupecki, consider the sequence of values as continuous, we arrange them in smaller or larger compounds of morphogrammatic units. As our nineplace pattern shows, it is not necessary that the values which fill and represent a morphogram form continuous four-place sequences. In fact this is impossible. No more than two values belonging to the same pattern can ever be direct neighbors. On the other hand there is no limit to how far they can be apart.

This too has weighty consequences for a general theory of reflection. The fact that we may connect individual morphograms only as allowed by their actual value-occupancy imposes, of course, certain limits on the construction of morphogrammatic compounds. The rules for it cannot be given within the frame of the present discussion. Instead we shall give a demonstration of how the $\mathfrak{R}$-operator handles values, and changes value occupancies, for a given array of morphograms. As a model we shall use a table of several value sequences belonging to a three-valued logic. We select our value-sequences with the stipulation that they shall represent only compounds of the morphograms [1] and [4]. This limits us to exactly eight sequences:

Table XIII

[4,4,4]	[1,4,4]	[4,1,4]	[4,4,1]	[1,1,4]	[1,4,1]	[4,1,1]	[1,1,1]
1	1	1	1	1	1	1	1
2	1	2	2	1	1	2	1
3	3	3	1	3	1	1	1
2	1	2	2	1	1	2	1
2	2	2	2	2	2	2	2
3	3	2	3	2	3	2	2
3	3	3	1	3	1	1	1
3	3	2	3	2	3	2	2
3	3	3	3	3	3	3	3

We shall now apply the operator for total reflection ($\mathfrak{R}$ without index) to the first sequence, which contains in all three positions the morphogram [4]. In order to demonstrate the effect that this operation has on the value-occupancy of all three patterns we will separate them in the intermediate stage:

Table XIV

$\mathfrak{R}$[4,4,4]	η_R			[1,1,1]
1	3		3	1
2	3			1
3			3	1
2	3			1
2	2	2		2
3		2		2
3			3	1
3		2		2
3		1	1	3

This table shows drastically that the $\mathfrak{R}$-operator is completely indifferent to the actual value-occupancy of the four-place pattern it transforms. It just changes morphograms into each other and implements these transformations with the values that are demanded by the value-occupancy of the key positions where the morphograms are joined together. This happens in Table XIV, at the first, fifth and ninth places in the column. Since the key values of the third morphogram exchange their places in the first and last

position of the column, the original values "1" and "3" are retained. This, however, is not possible in the case of the first and second morphograms. Here the key values are now "3" and "2" and then "2" and "1". These key values and the structure of the morphogram determine the other value occupancies. Since this treatment of values is rather unusual we shall demonstrate this issue of value-occupancy also for the $\mathfrak{R}$-operation of a single morphogram within a compound of three morphogrammatic patterns. We choose for the demonstration the first morphogram of [4,4,4] which has the standard form 1222:

Table XV

$\mathfrak{R}^1$[4,4,4]	η_1			[1,4,4]
1	2		2	1
2	2			1
3			3	3
2	2			1
2	1	1		2
3		3		3
3			3	3
3		3		3
3		3	3	3

Although the operator changes only the first morphogram [4] to [1], the value-occupancy of the other patterns is also altered. The first values of the second and third pattern are exchanged. By again exchanging all classic values ("1" and "2") with the help of the negation "η_1" we obtain the standard version of [1,4,4]. An explanation is due of how an $\mathfrak{R}$-operations applied to one or several morphograms within a larger compound. First, we produce the mirror-image of the morphogram that is affected by the $\mathfrak{R}$-operator. If the operator changes two or more morphogrammatic patterns, their combined value-sequence must be put down in reverse order. By doing so, possible intervals that are produced by values from other patterns must be observed. These intervals are then filled with the values that occur in the original sequence wherever there is such an interval. Thus after having reversed the sequence 1222 in Table XV the third, sixth, seventh, eighth and ninth place is filled with the corresponding values of [4,4,4]. The following Table XVI gives an example of the application of $\mathfrak{R}$ to two morphograms. This time we choose the patterns 1222 and 1333 of [4,4,4]:

Table XVI

$\mathfrak{R}^{1.3}$ [4,4,4]	η_R		[4,1,1]
1	3		1
2		2	1
3	3		3
2		2	1
2	2		2
3	2		3
3	3		3
3	2		3
3	1		3

In order to-illustrate how the $\mathfrak{R}$-operator works with two patterns the morphograms in the center of Table XVI have not been separated. First the value-sequence that is affected by $\mathfrak{R}^{1.3}$ is written in reversed order. This leaves us with two intervals. In the second column the values which [4,4,4] provides are written for the open places. The appropriate negation η_R then returns the value-sequence to its standard form for [4,1,1].

By operating [1,1,1] in a corresponding way we obtain the following definitions for several value-sequences of Table XIII. From Table XIV we derive:

$$[1,1,1] =_{Def} \eta_R \, \mathfrak{R}[4,4,4] \tag{4}$$

from Tables XV and XVI

$$[1,4,4] =_{Def} \eta_R \, \mathfrak{R}^{1}[4,4,4] \tag{5}$$

$$[4,1,1] =_{Def} \eta_R \, \mathfrak{R}^{1.3}[4,4,4] \tag{6}$$

And using [1,1,1] as definitorial basis we further obtain:

$$[1,4,1] =_{Def} \eta_R \, \mathfrak{R}^{2}[1,1,1] \tag{7}$$

$$[4,1,4] =_{Def} \eta_R \, \mathfrak{R}^{2.3}[1,1,1] \tag{8}$$

It is important to note that Table XIII contains two more morphogrammatic compounds which cannot be defined in this simple manner. [4,4,1] as well as [1,1,4] have specific properties which set them apart from the other value-sequences. It will be interesting to compare the Formulas (4), (5), (6), (7), and (8) with corresponding formulas, that use only negations and no $\mathfrak{R}$-operations. We obtain then DeMorgan-type relations that look as follows:

$$p[1,1,1]q =_{Def} \eta_R \, (\eta_R \, p[4,4,4] \, \eta_R \, q) \tag{9}$$

$$p[1,4,4]q =_{Def} \eta_1 \, (\eta_1 \, p[4,4,4] \, \eta_1 \, q) \tag{10}$$

$$p[4,1,4]q =_{Def} \eta_2 \, (\eta_2 \, p[4,4,4] \, \eta_2 \, q) \tag{11}$$

and with [1,1,1] as definiens:

$$p[4,1,1]q =_{Def} \eta_1 \, (\eta_1 \, p[4,4,4] \, \eta_1 \, q) \tag{12}$$

$$p[1,4,1]q =_{Def} \eta_2 \, (\eta_2 \, p[4,4,4] \, \eta_2 \, q) \tag{13}$$

Again [4,4,1] and [1,1,4] remain undefined. If we want a definition for them and still rely, apart from negation, only on [4,4,4] and [1,1,1] as definitorial basis we are forced to resort to the following cumbersome sequence of symbols:

$$p[4,4,1]q =_{Def} \eta_1 \, (\eta_1 \, p[1,1,1] \, \eta_1 \, q) \, [4,4,4] \, \eta_2 \, (\eta_2 \, p[1,1,1] \, \eta_2 \, q \,) \tag{14}$$

$$p[1,1,4]q =_{Def} \eta_1 \, (\eta_1 \, p[4,4,4] \, \eta_1 \, q) \, [1,1,1] \, \eta_2 \, (\eta_2 \, p[4,4,4] \, \eta_2 \, q \,) \tag{15}$$

It is, of course, possible to shorten Formulas (14) and (15) if we do not restrict ourselves to the use of [4,4,4] and [1,1,1]. However, there might be reasons when this restriction is desirable. The introduction of transjunction [13,13,13] provides us with such a motive. In two-valued logic disjunction may be defined by the use of negation and conjunction and the latter by the inverse procedure with disjunction. It would be important to have a corollary to DeMorgan´s law that would establish an analog basic

relation between conjunction and disjunction on one side and total transjunction in a three-valued system on the other. But if we do this with negational operations we arrive at the following involved formula:

$$p[13,13,13]q =_{Def} <\eta_1 (\eta_1 p[4,4,4] \eta_1 q) [1,1,1] \eta_2 (\eta_2 p[4,4,4] \eta_2 q)>$$
$$\eta_1 (\eta_1 p[4,4,4] \eta_1 q) [1,1,1] \eta_2 (\eta_2 p[4,4,4] \eta_2 q)$$
$$\eta_{2.1} < \eta_1 (\eta_1 p[1,1,1] \eta_1 q) [4,4,4] \eta_2 (\eta_2 p[1,1,1] \eta_2 q)> \quad (16)$$

By using the Formulas (14) and (15) we may, of course, reduce the awkward Formula (16) to the very simple formula:

$$[13,13,13] = ([1,1,4]) [1,1,4] (\eta_{2.1} [4,4,1]) \quad (17)$$

and

$$[13,13,13] = ([4,4,1]) [4,4,1] (\eta_{1.2} [1,1,4]) \quad (18)$$

But this is not exactly what we want. Here a new morphogrammatic distinction becomes important. Only two of the value-sequences of Table XIII represent one morphogram. They are [4,4,4] and [1,1,1]. We shall call sequences in which the same morphogrammatic pattern is repeated in all "places" of the system a monoform value-sequence. If more than one morphogram is used to cover all "places" we shall speak of a polyform structure. The polyform sequences [1,4,4], [4,1,4]) [4,4,1], [1,1,4], [1,4,1] and [4,1,1] are all we know so far. We see now that in Formulas (17) and (18) the monoform structure of [13,13,13] is equated with two polyform expressions. The relation is, in fact, interesting in many respects; but it is not what we want. We search for a corollary to DeMorgan´s law for our function [13,13,13].

Since all basic morphograms of the Tables VI and VIa must be classified as monoform it means that the DeMorgan law expresses a relation that is established with the exclusive use of monoform value-sequences. If we assume this morphogrammatic viewpoint Formulas (17) and (18) do not qualify as corollaries. Formula (16) does, but in such an awkward manner that we cannot. feel very happy about it. And since it is impossible to blame [4,4,4] and [1,1,1] for the length of the formula the blame must fall upon the η-operator.

One cannot help but wonder under the circumstances whether trans-classic systems of logic are basically also orders of value-assertion and value-negation. The Formula (16) leaves one with the impression that negation is somehow too weak an operator within these new realms. For this very reason we introduce the ℜ-operator. A many-valued system, interpreted as a morphogrammatic logic, is basically not a negational order but a system of reflection. This has never been clearly recognized by previous investigations in this field. The very meritorious researches of Lukasiewicz, Wajsberg, Slupecki and others still lean on the ontology of the Axistotelian terms of δυνατόν είναι (potentiality), ἐνδεχό μενον είναν (contingency) and ἀναγκίον είναι (necessity) as elaborated in "De Interpretatione". This is an ontology of objective Being but not of objective-subjective Reflection. But for any ontology of the object the natural way to handle values is to assert or negate them. Using Fichte´s symbolism (see Table X) we noticed that negation is equivalent to reflection for inverse value constellations like 1, 2 and 2, 1 or 1, 2, 3 and 3, 2, 1. It is true that Aristotle hints at a third value in the famous

ninth chapter[63] of "De Interpretatione", but this value seems to coincide with Fichte´s horizontal line. Very significant also is that considerable difficulties exist to complement the "third value" of Aristotle with a fourth. And it becomes almost impossible to interpret this ontology with five, six, or seven individual values. This was clearly recognized by Łukasiewicz. As early as 1930 he made the following statement: "Es war mir von vornherein klar, dass unter allen mehrwertigen Systemen nur zwei eine philosophische Bedeutung beanspruchen können: das dreiwertige und das unendlichwertige System[64]. This is undoubtedly true if the extension of traditional logic into trans-classic regions is based on "De Interpretatione". Aristotle´s "third value" can only be understood as the indifference (Schelling) between "true" and "false". Another way to put it is to say that the decision between the two values remains suspended because of the specific properties of the designated ontological situation. Aristotle is concerned with propositions in the future tense. He argues that it is still undetermined whether there will be a sea-battle tomorrow … or not. But although neither side of the alternative can be said to be true or false the disjunction itself: "Either this battle will be or it will not be" is accepted as true regardless of the future tense. And there will, or course, come a moment when the datum in question moves from the modal realm of possibility (δυνατὸν εἶναι) into that of reality or non-reality. Consequently the decision between the two values is suspended only because of the time element involved. It is now very easy to take the step from this third suspension value to a logic of probability. Since we have to assume that the interval between the δυνατὸν εἶναι and the ontological state of ἐνδεχὸ μενον εἶναν may be very long (and to all practical intents and purposes even infinite) the suspension may remain forever; the time for a final decision may never come. We have then to choose between probability values, of which there must be at least a denumerable infinity. A fourth, fifth, or sixth value between this third value of indifference and the infinity of probability data makes very little or no philosophic sense. One cannot help but agree with Łukasiewicz´s statement that finite m-valued systems where m > 3 have no philosophic significance.

Of course, it might be argued that Aristotle´s third "value" introduces reflection into formal logic … in a manner of speaking. Deciding to suspend the decision between two values is a sort of subjective reflection. This has already been admitted, and we discussed this type of subjectivity when we mentioned the part that is played by reflection in quantum mechanics. But we also cited Heisenberg´s comment that the probability functions are "completely objective" with regard to their semantic significance[65]. And this is what Aristotle is concerned about. His envisaged value of suspension designates exclusively possible or actual states of *objective* existence. His philosophical theme is – in his own words – τὸ ὀν = Being as an object. This ὀν turns up as the verb εἶναι in the modal terms which we quoted in the preceding paragraph. It is what the subject – faces, but never the subject itself! Obviously a logic which takes

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[63] Cf. Aristotle *De Interpretatione*, DC, 19 9. It seems to us that the καὶ μάλλον μέν ἀληθή τήν ἑτέραν indicates degrees of truth of falsity. In other, words: a probability logic where two - and only two - ontological values are distributed over an interval between them.

[64] J. Łukasiewicz: Philosophische Bemerkungen zu mehrwertigen Systemen des Aussagenkalküls. *Comptes Rendues des Séances de la Société des Sciences et des Lettres de Varsovie*, XXIII, class III, p. 72 (1930).

[65] W. Heisenberg: *Physics and Philosophy*. See Note 29, p. 53.

its bearings from the objective side of Reality is not very well equipped to deal with subjectivity as such and as a state of being in contraposition to any thinkable object.

The defenders of the classic position in logic may, of course, say that the ultimate Reality behind the Aristotelian ὀν and εἰναι namely the τὸ τἰ ἠν εἰναι is the absolute indifference of Object and Subject. But this is the viewpoint of a mystic. It cannot be the basis of a logic of cybernetics. This much may, however, be admitted: the minimum of reflection which is involved in the description of the external world as a bona fide object is indeed capable of defining subjectivity. In other words: it is possible to define the subjective function of transjunction [13,13,13] in terms of negation combined with conjunction and disjunction. We did so when we produced the Formula (16). It was based on the system $\{[4], \eta_1, \eta_2\}$. However, it took logic a long time to recognize the following point. It is not sufficient that we are *able* to describe something in formal terms: it is equally important how we describe it. This is one of the basic tenets of the transcendental logic of Kant, Fichte, Hegel, and Schelling. These thinkers were fully aware of the fact and pointed out that it is, of course, permissible to describe a subject exclusively in terms of objective existence and that there is no limit to such a description (for no subjective phenomenon can be demonstrated which could not be submitted to such a treatment). The procedure is in itself irreproachable. But by doing so, as Fichte and his successors point out, we have described a subject as an object. If we intended to do so, nothing more can be said. But if we intended to describe the subject qua subject we have failed! We have interpreted something in terms of *being* although we wanted to know something in terms of *reflection*. In order to avoid this mistake we introduced the $\mathfrak{R}$-operation. This gives us an opportunity to express the DeMorgan law in a double fashion. First it can be presented with the help of η. In this form it demonstrates structural relations of objective existence. But the same law may also be expressed with the $\mathfrak{R}$-operator. In this case we define it as a law of reflection. We still owe the reader this second definition. We shall produce it after a demonstration of the capacities of the $\mathfrak{R}$-operator in morphogrammatic compounds.

It is obvious that the concept of subjectivity in formal logic, as represented by the $\mathfrak{R}$-operation, has nothing to do with distribution of values. The logical unit of many-valued systems is the morphogram. η-operations cannot directly transform one morphogram into another because they deal with values and not with abstract patterns incorporated in more or less irrelevant values. But the new $\mathfrak{R}$-operator demands, in its turn, distribution of morphograms. We observed that if "$\mathfrak{R}$" is applied to single morphograms the result is sometimes nothing, sometimes a negation, and only in a few cases a second morphogram. But the few morphogrammatic compounds which we demonstrated in the Table XIII contained only the patterns [1] and [4] which are amenable to $\mathfrak{R}$-transformation even in their isolated state. We shall now show that in a morphogrammatic compound a given pattern can be transformed into any other pattern. If we look, for instance, at Table XIV we observe that after operation by $\mathfrak{R}$ (total reflection) the second morphogram, represented by the value sequence 2333, becomes the reflection of the first 1222. But 2333 appears, of course, as its mirror-image 3332 in this operation. One morphogram has been transformed into another but both belong to the same Table VII. We have not yet demonstrated that an $\mathfrak{R}$-operation may also t r a n s f o r m a non-transjunctional pattern into one with transjunction. If we want to establish a DeMorgan relation between disjunction and conjunction on one side and transjunction on the other we require exactly this sort of operation.

When we produced [1,4,4] and [4,1,1] with the help of $\mathfrak{R}^1$ and $\mathfrak{R}^{1.3}$ from conjunction (see Tables XV and XVI) we omitted to use $\mathfrak{R}^2$, $\mathfrak{R}^3$, $\mathfrak{R}^{1.2}$ and $\mathfrak{R}^{2.3}$ on [4,4,4]; and later we did not apply $\mathfrak{R}^1$, $\mathfrak{R}^3$, $\mathfrak{R}^{1.2}$ and $\mathfrak{R}^{1.3}$ in our definitions based on [1,1,1]. We will now apply these not yet used $\mathfrak{R}$-operators on conjunction and disjunction. The next two tables show the results:

Table XVII

[4,4,4]	$\mathfrak{R}^2$	$\mathfrak{R}^3$	$\mathfrak{R}^{1.2}$	$\mathfrak{R}^{2.3}$
1	1	3	3	3
2	2	2	3	3
3	3	3	3	3
2	2	2	3	3
2	3	2	2	2
3	3	3	2	3
3	3	3	3	3
3	3	3	2	3
3	2	1	1	1
[4,4,4]	[13,1,13]	[4,13,1]	[1,1,1]	[1,13,1]

and

Table XVIII

[1,1,1]	$\mathfrak{R}^1$	$\mathfrak{R}^3$	$\mathfrak{R}^{1.2}$	$\mathfrak{R}^{1.3}$
1	2	3	3	3
1	1	1	2	1
1	1	1	1	1
1	1	1	2	1
2	1	2	2	2
2	2	2	1	1
1	1	1	1	1
2	2	2	1	1
3	3	1	1	1
[1,1,1]	[4,13,13]	[13,1,4]	[4,4,4]	[13,4,4]

First it should be noted (see also Table XIV) that:

$$[1,1,1] = \eta_R\, \mathfrak{R}[4,4,4] = \eta_R\, \mathfrak{R}^{1.2}[4,4,4] \tag{19}$$

$$[4,4,4] = \eta_R\, \mathfrak{R}[1,1,1] = \eta_R\, \mathfrak{R}^{1.2}[1,1,1] \tag{20}$$

This operational identity of $\mathfrak{R}$ and $\mathfrak{R}^{1.2}$ is by no means general. The following example will show that $\mathfrak{R}$ and $\mathfrak{R}^{1.2}$ do not always produce identical results:

$$\mathfrak{R}[4,2,12] = \eta_R\, [2,1,9] \tag{21}$$

$$\mathfrak{R}^{1.2}[4,2,12] = \eta_R\, [2,1,1] \tag{22}$$

On the other hand:

$$\mathfrak{R}[4,2,12] = \mathfrak{R}^{2.3}\, [4,2,12] \tag{23}$$

A discussion of the occasional operational identity of total 'R with one of its sub-operators (although interesting in itself) goes beyond the scope of this investigation. However, we are very much concerned with the other $\mathfrak{R}$-operations of Table XVII and XVIII because they show us examples of transformations of classic morphograms into transjunctional patterns. The value-sequences thus obtained are polyform but with their help it is now easy to give a formulation of the DeMorgan law for transjunction using $\mathfrak{R}$-operators. Instead of Formula (16) we may now write:

$$[13,13,13] =_{Def} \eta_2 < (\mathfrak{R}^2[4,4,4])\ [1,1,1]\ (\eta_{1.2}[1,1,1]) > \qquad (24)$$

This expression satisfies our stipulation that only the monoform sequences of conjunction and disjunction may be used. The considerable reduction in negational operations that Formula (24) represents when compared with Formula (16) shows that the reflectional element contained in η is not adequate to cope with a logic of reflection.

We may approximate the classic law of DeMorgan even further. Instead,of using both, conjunction and disjunction, to express the value-sequence of transjunction we may confine ourselves to one of the two. If we choose disjunction we obtain the desired formula by a simple substitution which gives us the new definition:

$$[13,13,13] =_{Def} \eta_2 < (\eta_R\mathfrak{R}^2\mathfrak{R}[1,1,1])\ [1,1,1]\ (\eta_{1.2}\mathfrak{R}^1[1,1,1]) > \qquad (25)$$

By an analog procedure we can define transjunction with the exclusive use of conjunction.

$$[13,13,13] =_{Def} \eta_1 < (\eta_R\mathfrak{R}^1\mathfrak{R}[4,4,4])\ [4,4,4]\ (\eta_{2.1}\mathfrak{R}^2[4,4,4]) > \qquad (26)$$

It stands to reason that no transformation of a classic morphogram into morphogram [15] can be accomplished with nineplace value-sequences. But this situation is easily remedied by progressing to a system which requires four values. The procedure then is analogous.

The Aristotelian ontology which advances *à la* Łukasiewicz from a hypothetical third value of logical indifference between "true" and "false" directly to an infinity of probabilities would make the introduction of an individual fourth value very difficult from the interpretational viewpoint. In a theory of objective existence the fourth value seems to represent a redundancy. It has no status of its own to keep it apart from the subsequent values. In the theory of morphograms it is different: there value four has a special significance insofar as a three-valued system is, morphogrammatically speaking, still incomplete. And in the first philosophical theory of consciousness which really deserves the name[66] – the Transzendentale Elementarlehre in the *Critique of Pure Reason* – Kant provides a table of categories[67] which, so he points out, represent the basic logical structure of the mind. These categories are subsumed under four primordial motives of consciousness which he calls:

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[66] M.Bense: Bewusstseinstheorie, Grundlagenstudien, II, 3, P. 65 (1961).

'Beuwsstseinstheorie im Sinne einer philosophischen Theorie, also einer Theorie, deren Aussagen erkenntnistheoretisch und ontologisch hinreichend allgemein formuliert sind, so dass sie von einer speziellen Fachwissenschaft unabhängig bleiben, aber für jede verbindlich sind, *gibt es erst seit Kan*t.´

[67] B 106; See also B 95.

quantity
quality
relation
modality

This would require, so far as a formal logical theory of consciousness is concerned, a system with four values. That means a structural order which is morphogrammatically complete. Thus the fourth value has a specific significance. But this significance could not mean anything to Aristotle because his philosophical theme is objective Being, and not its subjective reflection as awareness and self-consciousness.

This should take care of the fourth value. However, we have to admit that it does not solve the problem of the ontological identification of a fifth, sixth or any subsequent value. And unless we resign ourselves to their interpretation as probabilities we have to admit that the task of identifying a potential infinity of values with regard to their individual semantic significance, other than modality or probability, is hopeless. This is a further motive for giving up the value theory and for resorting to the morphogrammatic interpretation of trans-classic systems of logic. It is justifiable to call these systems non-Aristotelian because the concept of the morphogram means a departure from the way a trans-classic logic has to be developed if such development is guided by Aristotle´s speculations in "De Interpretatione".

The non-Aristotelian viewpoint considers logical systems which transcend the scope of the two-valued traditional theory as vehicles of the distribution of systems. And since each individual morphogram indicates the place of a two-valued logic, ion, which is, of course, disturbed by the "noise" of transjunction, we might as well say that a many-valued logic is a place-value order of morphograms and of compounds of morphogrammatic patterns. This relegates the concept of value in these higher systems to a subsidiary role. The use of value, and therefore the use of negation, is still necessary because it is impossible to construct compounds of morphograms in a logical sense without value-occupancy. But it is not the value but the morphogram which determines the semantic s i g n i f i c a n c e of the non-Aristotelian theory of thought. The classic concept of ratiocination is incomplete only from the morphogrammatic viewpoint. And it is this new aspect which introduces the idea and the operations of transjunction. The concept of a value of rejection is incompatible with the metaphysics of Aristotle. His hypothetical third value from the ninth chapter of "De Interpretatione" is anything but a rejection of the alternative of the two values on which his theory of thought is based.

If we interpret many-valued systems as place-value orders of morphograms and morphogrammatic compounds we should say something about the formal composition of these arrangements, which grow rapidly in complexity if more values are introduced. The two-valued system is not only morphogrammatically incomplete, as we have frequently noted: it is also not a compound of morphograms. Only one morphogram may be used at a time and in a single operation as far as the definition of such operations as conjunction, disjunction, conditional and so on is concerned. A three-valued system is morphogrammatically richer although still incomplete, as we know, but it also represents morphogrammatic compound structures. A four-valued system is finally both. It is complete as to the number of morphograms and it is also an order of compounds. It is important not to confuse the hierarchy of value-systems with the hierarchy of

morphogrammatic compounds. A three-valued system using three connected morphograms incorporates just 3 "four-place" sub-systems which are basically "two-valued" *but open for transjunction.* A four-valued system represents 6 "two-valued" logics, 4 "three-valued" systems and 1 "four-valued" formal order. The number of two-valued subsystems for any m-valued order is

$$\frac{m^2 - m}{2}$$

Moreover, any m-valued logic has m sub-systems of the value-order m-1. Generally it can be said that the number of s-valued sub-systems that are formed by an m-valued logic is

$$\binom{m}{s}$$

when $s \leq m$. The following Table XIX gives the values for $\binom{m}{s}$ where s ranges from 2 to 7:

Table XIX

m	$\binom{m}{2}$	$\binom{m}{3}$	$\binom{m}{4}$	$\binom{m}{5}$	$\binom{m}{6}$	$\binom{m}{7}$
2	1					
3	3	1				
4	6	4	1			
5	10	10	5	1		
6	15	20	15	6	1	
7	21	35	35	21	7	1
…	…	…	…	…	…	…
…	…	…	…	…	…	…

According to our table a five-valued logic would include as subsystems 10 "two-valued" logics, the same number of "three-valued" systems, and 5 "four-valued" logics. We have put the value-designation in quotation marks because they all permit rejection values to enter their order. A "two-valued" subsystem in a "three-valued" logic is determined by 3 values. This awkwardness shows the inadequacy of the value concept when applied to higher systems of logic. It is more adequate to say that a three-valued logic is a compound of 3 morphograms.

Table XIX is nothing but a fragment of the well-known table of binomial coefficients[68] adopted for our purpose. An interesting fact that can be obtained from Table XIX is that the sum of the numbers of all sub-systems of s^{th} order for a given m-valued logic is always equal to the number of sub-systems of s + 1 order in a logic with m + 1 values. It is implied that each logic contains itself as sub-system.

[68] The author is indebted to Professor H. von Foerster for having drawn his attention to this fact.

In the described sense we may interpret all m-valued systems of logic, classic as well as trans-classic, as place-value systems of sub-logics with the order indices 1,2,…,m-1. It is by no means superfluous or trivial that we include the two-valued logic. The very fact that the traditional logic, in its capacity of a place-value structure, contains only itself as subsystem points to the specific and restricted role which reflection plays in the Aristotelian formalism. In order to become a useful theory of reflection a logic has to encompass other sub-systems besides itself.

More important than the interpretation of all logics as place-value systems of suborders that are made up of values is the morphogrammatic orientation which looks at a given logic as a set of morphograms and morphogrammatic compounds. In the classic logic these two concepts coincide. There are no compounds in the proper sense unless we say that each morphogram represents its own compound. In any m-valued system where m > 2 they differ. It stands to reason that the number of morphograms which make up a compound is always identical with the number of first order systems which are incorporated in a given logic. In one (and the most important) respect, however, there is no difference between the Aristotelian and the many-valued logic: the number of morphograms and morphogrammatic compounds is always smaller than the number of value-sequences or functions. A two-valued system has eight morphograms which are represented by 16 functions of four places. A three-valued logic possess $3^9 = 19683$ nine-place value-sequences. The number of morphograms that are represented in it is, as we know, 14 and the system is therefore not yet morphogrammatically complete. However, as far as unique morphogrammatic compounds are concerned this system contains 1 compound represented by one value, 255 compounds incorporated by two values, and 3025 compounds where the structure requires three values for systematic representation. In the classic system all morphograms claim double value occupancy. In the three-valued system we find the following correlation between values and morphogrammatic compounds:

Table XX

compounds	value-occupancy
1	3
255	6
3025	6

The more comprehensive the logical systems become, the higher is the rate of value-occupancy, or the smaller becomes the number of unique morphogrammatic structures compared with the number of value-sequences that represent them in a given logic. The author´s attention was drawn by H. von Foerster to the fact that the number of ways μ(m) in which m values can be put into n different places can be defined with the aid of S(n,k), the Stirling numbers of the second kind[69], the first few values of which are given in Table XXI. It can be shown that

[69] J. Riordan: *Introduction to Combinatorial Analysis*, Wiley, New York (1958); See p. 32 ss, Table p. 48.

$$\mu(m) = \sum_{i=1}^{m} S(m^2, i) \tag{27}$$

Thus, if we wish to know the number of morphograms, or morphogrammatic compounds, the answer will be given by Formula (27).

Table XXI

n / k	1	2	3	4	5	6	7	8	9
1	1								
2	1	1							
3	1	3	1						
4	1	7	6	1					
5	1	15	25	10	1				
6	1	31	90	65	15	1			
7	1	63	301	350	140	21	1		
8	1	127	966	1701	1050	266	28	1	
9	1	255	3025	7770	6951	2646	462	36	1

In a two-valued logic we have, e.g.:

$$\mu(2) = \sum_{i=1}^{2} S(4, i) = 1 + 7 = 8$$

Or, in the case of a three-valued system:

$$\mu(3) = \sum_{i=1}^{3} S(9, i) = 1 + 255 + 3025 = 3281$$

There is, however, another aspect to the theory of the morphogrammatic compounds which we will call their μ-structure. It arises from the formula:

$$\bar{\mu}(m) = \sum_{i=1}^{m^2} S(m^2, i) \tag{28}$$

We require Formula (28) as justification of our statement that a logic of reflection has 15 basic morphogrammatic units. If we assign m the value 2 then we obtain from Formula (28)

$$\bar{\mu}(2) = 15$$

the number of morphograms represented by Tables VIa and VIb. However, Formula (28) has a deeper significance. If we equate m = 3 then

$$\bar{\mu}(3) = 21147$$

Since we know that a three-valued logic has only $3^{3^2} = 19683$ value-sequences it seems to be stark nonsense to ascribe to a trinitarian logic 21147 morphogrammatic compound structures. It is indeed impossible if we assume that 3 is the highest value in the system; or to put it into different words that our logic is only a sub-system of itself. In this case Formula (27) applies. On the other hand, we face a different situation if our trinitarian logic is a sub-system of, let us say, a logic with 9 values. The number of rejection values any two-valued system may have within an m-valued logic is always m-2. If a three-valued logic is only a sub-system of itself only one rejection value is available for each of its two-valued sub-systems. But if the same trinitarian logic is part of a nine-valued structure of reflection our Table IX would grow into Table XXIV.

Table XXIV

p	q	[1]	[4]	[13]	[13]	[13]	[13]	[13]	[13]	[13]
P	P	P	P	P	P	P	P	P	P	P
P	N	P	N	3	4	5	6	7	8	9
N	P	P	P	3	4	5	6	7	8	9
N	N	N	N	N	N	N	N	N	N	N

Table XXIV demonstrates clearly that nothing is or can be added to the morphogrammatic structure of "two-valued" logic. But the case is quite different for the trinitarian system. By being a sub-system of a nine-valued order of reflection it acquires a greater richness of morphogrammatic structure. We give as an example a value-sequence which may occur in a trinitarian system if and only if it is a sub-system of a logic where $m \geq q$:

1 2 3 4 5 6 7 8 9

This is a function with the morphogrammatic order [15,15,15] which a three-valued logic that is only a sub-system of itself could not have. If the trinitarian system is a sub-system of, e.g. a four-valued logic, the increase of morphogrammatic richness would be considerably smaller. But there is a limit for such an increase. It is given by the formula

$$\bar{\mu} - \mu$$

which in the case of a three-valued logic is

$$\begin{aligned} \bar{\mu}(3) &= 21147 \\ -\mu(3) &= 3281 \\ \hline & 17866 \end{aligned}$$

No doubt the increase in morphogrammatic compound structure is impressive. But for a "three-valued" logic it ends with that number. Generally, no sub-system will increase its morphogrammatic richness if $m > s^2$.

Every logic, if included as a sub-system in a higher order of reflection finally reaches a point of morphogrammatic saturation, provided, of course, that s is finite. For a

two-valued logic this stage is reached when the classic system is incorporated in a four-valued order. If, e.g., [15] as a four-place sequence is penetrated by higher values and assumes, let us say, the shape 1792, the original transjunction is monotonously iterated. As far as the classic system is concerned no new logical motive has been added. We all know from our own psychological introspection that our consciousness has a capacity for a theoretically unlimited self-iteration of its concepts. Fichte has drawn our attention to its (negative) logical significance. We have, he says, a concept of something and may iterate it into a:

concept of a concept of a concept……of something

and so on *ad nauseam*. He and later Hegel point out that after the second step no increase in logical structure can be expected. The endless iteration of our reflection is, to use a term of Hegel, "eine schlechte Unendlichkeit" (a bad infinity). It is important to point out that there are indeed two utterly different ways in which a formal increase of reflection may be obtained: first, by (empty) iteration of a morphogrammatically saturated system and second, by a growth of morphogrammatic structure. It is a serious argument against the reflective power of the infinite hierarchy of two-valued meta-systems that this hierarchy represents an iteration of the first kind.

From a logical point of view it is also important to know that there is a semantic difference between the morphogrammatic structure any m-valued system has as an independent logic and the additional structure it gains by becoming a sub-system of a more comprehensive order of reflection. It will be useful to stress this difference by speaking of morphogrammatic compounds of first and second order. The first is by far the more important – at least as far as the semantic interpretation plays a part.

Despite the rapid growth of the first order compounds their numerical ratio to the value-sequences grows steadily smaller. This gradually enhances the importance of the morphogrammatic structures. The higher the rate of their possible value-occupancy the more flexible they are in their employment for a theory of reflection or subjectivity. In our traditional logic they cannot be used at all in this sense since their value-occupancy means a strict alternative of two values producing a perfect involution. Morphograms indicating transjunction are useless in this situation. It may be said that the concept of Being or of Reality developed on the platform of two-valued logic is entirely irreflexive. This is why Schrödinger´s complaint that it is impossible to discover subjectivity and subjects in our present scientific world-conception is more than justified. If a morphogram changes its value-occupancy, and there is only one other value available, and this value entails perfect negational symmetry (Nicholas of Cusa´s *coincidentia* oppositorum), then nothing is gained by this change – except the insight into the futility of this operation for a theory of reflection.

This helps us to obtain a reliable definition of what we mean when we use the terms "irreflexive", "reflexive" and "self-reflexive"[70]. We shall stipulate that we refer with the first concept to those structures of any system that can be described by a logic which uses only the morphograms [1] to [8]. Thus the value-occupancy is automatically

[70] This is the distinction which occurs in Hegel's Logic as ´Reflexion-in-Anderes´, ´Reflexion-in-sich´ and 'Absolute Reflexion´. Cf. Hegel, ed. Glockner (See Note 45) IV, p. 493 ss; VIII, p. 288.

restricted to two inverse values. In other words, there exists a symmetry between the designating and the non-designating value. A system which is described with the exclusive use of categories derived from a logic with the above morphogrammatic restriction has a most significant property: *it has no environment of its own!* Environment would mean a third value! It also means structural asymmetry**.** If one reads H. von Foerster´s essay *On Self-Organizing Systems and Their Environments* with the eye of a logician then it is not difficult to discover this lack of logical symmetry between what is supposed to be the system itself and its possible environment.

In fact there is only one system known to us which forces us, by logical necessity, to conceive it as having no environment. It is the objective universe as a whole representing the sum total of Reality. This is why our traditional logic applies so perfectly to all of *it* – so long as we are willing to forget about the subject. The very moment we say that we perceive the Universe, it has acquired an enveloping environment: the "space" of perception. And it does not help us in the least if we argue that the dimension of perception is enclosed in the Universe. In the same essay, H. von Foerster correctly points out that it is irrelevant whether the environment is inside or outside the "closed surface" which separates it from that which it "envelops"[71].

Our classic tradition of science assumed that it was possible to treat, even inside the Universe, certain data of observation in total isolation and without regard to an environment. Quantum mechanics has first disabused us of this notion. But having an environment and being affected by it is one thing. A probability logic takes care of this situation. Quite a different thing is a system which *reflects* its environment by organizing itself and producing additional structure. An elementary particle which is affected by the observation does not do so: the closed surface is missing. Logically speaking, the applied values are just diffused and distributed over an area of uncertain character. But such a structure-producing action takes place in von Foerster's experiment with the magnetized cubes. The "noise" which enters the box containing them is reflected in an incredibly ordered structure. We have already pointed out that it is senseless to view this situation with categories which have sprung from a probability logic. In the case of the cubes a phenomenon of distribution is again involved, but it is no longer a distribution of single data, with corresponding individual probability values, but of arrays of data which are capable of forming systems. It is evident that this requires the service of a logic which is capable of distributing systems. The basic unit of such a logic must be something which represents an array of data. This unit is the morphogram.

We have demonstrated that such a logic exists, and we have also shown that the introduction of morphograms with transjunctional structure, [9]-[15], produces a distribution of systems. If we ignore the value-occupancy of our structures we call the distribution of our original four-place morphograms over different positions a morphogrammatic compound. If we look at the same structure from the viewpoint of value-occupancy, we speak about a many-valued logic having a given number of m, m-1, m-2,…,m-n valued sub-systems. Both aspects are essential. The first is necessary because it indicates the structural incompleteness of two-valued logic and it provides us with a new logical unit, the morphogram, which is capable of representing a system and

[71] Loc. cit., p. 31.

at the same time of demanding distribution if we intend to apply more than one of these structural patterns in the, same binary function. The second aspect is essential because the morphograms, to be fully usable in terms of logic, have to be occupied by values; and values are the only means by which their distribution may be accomplished. If a many-valued logic is basically a place-value system of distributed morphograms then such places of distribution must be marked by values. If, for instance, 123223333 represents a function in which the morphogram [4] is distributed over four places then the first position is indicated by the value-sequence 1222. What we decide to call the second place is occupied by 2333 and the third place shows its location by using 1333.

These 3 four-place sequences may be considered mutual "negations". But negation in a many-valued system has, under certain conditions, an entirely different function from the corresponding operation in traditional logic. If we negate 1222 and obtain 2111 in classic logic we have negated the *meaning* of the original sequence. But if we apply the negator η_2, thus changing 1222 to 1333, we insist that the second value-sequence carries exactly *the same meaning* as the first. What the operator did was only to shift the meaning from one given location in a system of reflection to some other place. A change of values in a many-valued order may under given circumstances produce a change of meaning. But it does not necessarily do so. In traditional logic a value has one and only one function. By negating one value it unavoidably *accepts* the other one as the only possible expression of a choice. And by doing so it implicitly accepts the alternative that is offered by the given values. In this sense negation is a function of acceptance in the classic theory and the values "true" and "false" are *acceptance* values. All thinking starts from the primordial fact that there is something to think about. Consciousness is, seen from this angle, nothing but the acceptance of the fact that there is an objective world. And if we think about this objective "there is" we use only the morphograms [1] through [8] which can be arranged in a logic where each value functions as an acceptance value. And here a change of value results always in a change of meaning. A negated conjunction is not a conjunction anymore. It now carries a different meaning. It signifies incompatibility.

As soon, however, as we enter the domain of many-valued logic by making use of the morphograms [9] through [15] all values assume a second function. They may or they may not be acceptance values. And if they are not, then they represent *rejection*. In our standard form of morphogram [13] as shown in Table IV the value "3" represents a rejection. But any value may be considered a rejection value. If a given system provides for its variables, in a specific instance, the values "2", "3", "4" "5" and "6" and the applied function chooses "1" the selected value represents a rejection of the structural context which is circumscribed by the offered values. If the value-sequence [4,4,4] of Table XIV gives us conjunction with the standard and two "negated" value-occupancies the η-operations which determine the relations between these 3 four-place sequences do not change the meaning of [4]. Instead of it they state the fact that conjunction is also valid within two additional structural contexts which originate from the rejection of the $1 \longleftrightarrow 2$ alternative. In other words: [4,4,4] asserts that conjunction is simultaneously valid on three different levels of reflection and that these levels are related to each other via the operations $\eta_{2.1}$ and η_2. In this specific case it is the value "3" which transjugates the meaning from one sub-system to another.

Table XXII

[4]	$\eta_{2.1}[4]$	$\eta_2[4]$
1	2	1
2	3	3
2	3	3
2	3	3

By interpreting transjunction as a logical act of rejection this type of operation acquires a specific cybernetic significance. We have already suggested on a previous page that transjunction isolates a system (by rejecting it). In doing so, it produces the distinction between a closed system and its environment. This is exactly what a two-valued logic can never do. Its very nature of having only two values makes it impossible. One value is not sufficient to define a system. Every description of it absorbs two values! But the very same values which do the job of describing it cannot be used to tell us what it means to have an envelope around it (Wittgenstein). For this very purpose we require a value which *transcends* the scope of the system. However, as we have seen, there is no way to make such a value operable as long as we stick to the classic ontology and the concomitant logic of Being-as-the-irreflexive-It. For this logic only Reality as Totality has a closed surface. In other words: all of the Universe may be considered a system of "retroverted" self-reflection. It is retroverted because the Universe as such has no environment. Or, to put it differently, the environment coincides with the system it "envelops".

On the other hand, when we speak of individual centers of self-reflection in the world and call them subjects we obviously do not refer to retroverted self-reflection. Such individual centers have, as we know very well, a genuine environment (which the Universe has not!) and what they reflect is this very environment. It stands to reason that these systems of self-reflection with centers of their own could not behave as they do unless they are capable of "drawing a line" between themselves and their environment. We repeat that this is something the Universe as a totality cannot do. It leads to the surprising conclusion that *parts of the Universe have a higher reflective power than the whole of it*, as has been recognized for a long time. In Hegel´s logic the phenomenon of reflection is subdivided into three parts: He defines them as:

a) retroverted reflection (Reflexion-in-sich)
b) transverted reflection (Reflexion-in-Anderes)
c) retroverted reflection of retroversion and transversion (Reflexion-in-sich der Reflexion-in-sich und-Anderes)

Section (a) represents the physical system of the external world described by its specific reflective properties. But (b) and (c) signify the additional capacities of reflection which sub-systems of the Universe must possess if they are to be called subjects.

This shows that the early philosophic theory of reflection is still ahead of the present logical state of cybernetics. We talk about self-organizing systems and their environments; but Hegel´s distinction between (a), (b) and (c) shows that this is not enough. A self-reflective system which shows genuine traits of subjective behavior must be capable of distinguishing between two types of environment and be able to react

accordingly. First it must reflect an "outside" environment which lies beyond its own adiabatic shell and second it must be capable of treating (b) as an environment to (c). These two environmental meanings are not yet clearly distinguished in present cybernetics although von Foerster´s experiment with the magnetized cubes may give a very rough idea of it. The cubes themselves obviously require two different environments in order to build up their complicated architecture. They could not do so unless they possessed an environment inside the box where they could move freely. If there was no such environment, i.e., if they were locked in their initial position no structure could originate. But it is equally obvious that a second environment is required as place of origin of the "noise." In our example the three orders (a), (b) and (c) are rather haphazardly thrown together. They do not represent a fully organized system of reflection – although there is reflection of a very artful kind – but the arrangement gives at least an approximate idea of what is meant when we say that a system showing subjective traits of behavior must have an inner *and* an outer environment. And it must have the inherent ability to distinguish between the two.

This leads us back to transjunction and to our interpretation of transjunctive values as operations of rejection. We stated that if a system is rejected the value which acts as rejector places itself outside of it. By doing so, it establishes a boundary or a logically closed surface for the rejected system. In other words: it makes a distinction between the system and something else, i.e., an environment. This is achieved by the operations trans-classic values perform on the basis of the morphograms [9] through [14]; but we know: a logic which uses only the patterns [1] through [14] has at its disposal only one rejection value for a given two-valued system. Thus it can only establish one boundary and one environnient for the system it rejects. In other words: the distinction between an inner and an outer environment does not yet exist on the level of a three-valued logic. However, there is still one morphoaram left which becomes usable in a four-valued system. It is morphogram [15] which incorporates two different values of rejection as Table XXIII shows:

Table XXIII

		(15)
1	1	1
1	2	3
2	1	4
2	2	2

If we look at our standard value sequence which represents this operational pattern we notice as trans-classic values "3" as well as "4". Both of them have in common that they reject the alternative $1 \longleftrightarrow 2$. And since value "4" implies the logical power of "3" both share in this operation. In other words: for the reflective level of "3" the operation is total. The system $1 \longleftrightarrow 2$ is now clearly separated from an environment. But "4" has an additional power of rejection. It establishes a second environment within the sphere of rejection itself. This new environment has a weaker boundary. We all know what this means from our personal introspection. Our capacity to reflect upon our own thoughts and thought-processes implies that we are capable to make our own system of reflection the environment of a second order reflection. In other words: systems of reflection and environment may reverse their roles. Expressed in morphogrammatic terms: the pattern

remains the same if we write [15] as sequence 1342 or as 1432. But there is a difference with regard to the functional significance for $1 \longleftrightarrow 2$ implied in the exchange of the positions for "3" and "4".

It goes beyond the scope of this investigation to discuss the functional significance of the exchange relation between 1342 and 1432. If we did so it would lead us into very intricate questions about the outer and the inner environment of self-reflective systems. We have confined our theory of transclassic logic to the development of some basic terms of reflection which we derived from von Foerster´s experiment. It served us well as a starting point for our discussion of a logic with transjunctional operations. Transiunction was interpreted as "noise" relative to a two-valued system. We then showed that the only possible logical interpretation of subjectivity is formally equivalent to the order-from-noise principle. Thus we equated noise with subjectivity. However, it seems rather preposterous to say that von Foerster´s experimental arrangement displays a subjectivity of its own. Although the noise that effects changes in the arrangement of the cubes has a general transjunctional (= subjective) character it lacks an essential quality. Von Foerster´s principle does not permit us to distinguish between the different varieties of transjunction. Ergo, it is impossible to define in reflective terms what is inner and what is outer environment, not for us, but for the noise. There is, of course, a crude analogy to the distinction between an inner and an outer environment which every subject (potentially) has. In von Foerster's experiment it is the difference between the environment of the box and the environment of the cubes inside the box. The question may be settled for us, but we are idle spectators in this situation. Our opinions are quite irrelevant. The important issue is: what is inner and outer environment for the noise as the "soul" of this self-organizing system? If the cubes form a strange architecture is this something the noise erects in its external world in the way we build cathedrals, airports or communities ? Or does this architecture belong to the inner (subjective) environment of this organizing principle and do the cubes and their arrangement play the part of the "thoughts" of von Foerster's principle? The structure of the experiment in question is, of course, too undifferentiated to answer these and similar questions. But it is highly instructive to see how many formal characteristics of subjectivity, e.g. distribution of systems, transjunctional organization, inner and outer environment, rejection and self-reflection are incorporated in such a simple arrangement. That these traits display themselves in a very rudimentary form is of much less importance than the fact that they exist at all and can be demonstrated in such primitive experiments.

The issues of an advanced theory of reflection cannot be discussed on such a narrow experimental basis. Least of all the problem: what is inner and what is outer environment of a system that behaves as a fully developed subject of reflection? to obtain a complete answer to this question would be equivalent to the challenge to construct a trans-classic ontology of the subject as detailed as the classic ontology of the object. This is a goal that lies in a distant future.

5. SUMMARY

We are coming to the conclusion of our discussion on ontology and transjunctional logic in cybernetics. Our argument started with the observation that cybernetics requires an ontology and logic which provides us with a basis from which we may include the

subject and the general phenomenon of subjectivity into a scientific frame of reference without sacrificing anything of clearness and operational precision. We hope to have shown that this is entirely within the range of our logical capacities. We defined subjectivity as logical distribution and we distinguished between distribution of values and of systems which are formed by groups of values. The basic units of such groups we called "morphograms". From there the concept of a place-value system of morphograms and morphogrammatic compounds originated. This theory brought forth the idea of a set of logical operators called transjunctions. A short analysis of these operators led to the discovery that logical values have two basic functions: they can be considered either as acceptance values or as rejection values. In classic two-valued logic values are only capable of acting as acceptance values. In a morphogrammatic logic with m > 2 they also function as rejection values. Herein lies the difference between their objective and subjective significance. In a complete system of logic, referring to the object as well as to the subject, a value must always carry a double semantic meaning, namely being a value *of something* and for a *subject* of reflection. Our final Table XXIV illustrates this inverse relation:

Table XXIV

for	value	of
	acceptance	object
subject	rejection	

The difference in the functional character of the values which occupy the various places of the morphograms and their compounds is far reaching. The acceptance capacity of a value is precisely limited to the values that are offered for acceptance. In other words: *there are no degrees of freedom in this function.* If a value sequence which results from a binary operation is designated as a conjunction, then the higher value must be chosen in a two-valued system. However, it is different with rejection. A system 1⟷2 may be rejected by "3" or "4" or by any higher value we care to select, provided our logic is of an order sufficiently comprehensive to provide the value we intend to use for this operation. Theoretically our choice is infinite. This situation refers to the often observed and widely discussed infinite iterativity of systems with total reflection of the order (c). The subject seems to be bottomless as far as its "self" is concerned. This however is, from the viewpoint of the logician, an unwarranted assumption. We are only permitted to say that a system represents all structural characteristics. of subjectivity if it is complete with regard to the number of basic morphograms and functional representations. As a further provision it requires a logic with two stages of rejection over and above the number of values that are demanded for the description of its physical properties. In this sense a cyberneticist may talk in a definite, communicable and computable manner about the subject.

ACKNOWLEDGMENTS

I wish to acknowledge my indebtedness to Warren S. McCulloch for most stimulating talks, for his encouragement to continue along my lines of a philosophic investigation of the logical foundation of cybernetics, and for many of his published ideas.

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advise me as to the proper representation of my theme, and how to avoid several serious errors. He sacrificed much of his precious time to go most carefully over my text. H. von Foerster's influence goes even further. That I have changed my theory of the morphograms since its first presentation in the *Grundlagenstudien aus Kybernetik und Geisteswissenschaft* (1960) is exclusively due to ideas and suggestions of his. Beyond this he took an active part in formulating my comments on the Stirling numbers. In fact, several sentences in this part of the text are literally his. He also advised me to replace a formula concerning the number of morphogrammatic compounds in trans-classic systems, which gave only approximation, with Formula (27). It goes without saying that, notwithstanding my grateful acknowledgments, I take full responsibility for the text *and* the ideas contained therein.

Finally, I am very much indebted to Miss Hwa-Sung Hsieh and Mr. George W. Zopf for correcting the galley-proofs.

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Gotthard Günther [*]

Formal Logic, Totality and The Super-additive Principle

If the title of this paper combines Formal Logic and Totality (Ganzheit) it is resisting a general trend which is still strong in present scientific activities. The most comprehensive theory of Totality which we possess is contained in Hegel´s logic. But every student of this thinker knows how emphatically Hegel denounces formalization. According to him the structure of all totalities is "dialectic". Formal logic is based on a strict dichotomy of form and content (matter). But dialectics fuses the two in the superadditive principle of synthesis which combines thesis and antithesis in a way in which the contradiction between the two is not only retained but elevated to a higher level. The general consensus still is that the retention of contradiction – which is indeed demanded by all systems to which we ascribe the character of totalities – obviates all attempts of formalization. This belief is now more than two thousand years old and it is hard to shake.

However, a re-evaluation of the theory of dialectics and its super-additive principle, where the whole is more than the sum of its parts, has recently become a pressing necessity. Among the new scientific disciplines which have sprung up in recent times Cybernetics seems to have the widest interdisciplinary spread. The topics it deals with range from mathematics (information theory) and physics (quantum mechanics) over biology (bionics) to the theory of consciousness, of culture and of human history.[1] It Is hardly necessary to point out that the problem of the structure of totalities turns Up various aspects within-the scope of Cybernetics. Nevertheless a basic investigation into the formal logical texture of totalities is still missing. The ancient prejudice that such inquiry loads us straight out of the realm of formal, codifiable procedures of logic is still too strong.

Some progress has been made just the same. In a very relevant paper on biologic "coalitions"[2] H. von Foerster has pointed out that such phenomena are characterized by what he calls, a super-additive nonlinear principle of composition where some measure Φ of the whole is more than the sum of the measures of its parts:

$$\Phi(x+y) > \Phi(x) + \Phi(y)$$

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reprinted in: Gotthard Günther, *Beiträge zur Grundlegung einer operationsfähigen Dialektik*, Band 1, Meiner Verlag, Hamburg, 1976, p.329-351.

1 In this respect attention is drawn especially to the Russian efforts in this field. Cf. A. I. Berg, *Kiberneticu na Sluzhbu Kommunizmu*, Vol. I, Moscow/Lenongrad 1961. (Engl. Translation. *Cybernetics At the Service of Communism*, Publ. Joint Publ. Research Service, Washington D.C. JPRS 14592). Also: *Filosofskye voprosy Kibernatiki* (*Philosophical Problems of Cybernetics*, JPHS 11503),

2 Heinz von Foerster, *Bio-Logic*, in: Biological Prototypes and Synthetic Systems) I; Plenum Press, Now York 1962.

H. von Foerster´s argument cannot be repeated in detail. It will be sufficient to say that by applying the concept of "logical strength" (Carnap, Bar-Hillel) according to which a truth function increases its strength with the number of negative values it applies the author shows that a "coalition" of two statements A and B signifies such a super-additive principle:

A	B	≡	&
1	1	1	1
0	1	0	0
1	0	0	0
0	0	1	0

(I)

Table (I) shows on the left side the value constellations (0 for negative and 1 for positive) of the statements A and B. It is obvious that the logical strength of each is ½. On the right side we have first the equivalence relation (≡) of A and B which gives us their average strength as a result of what may be called a normal adjunction. This average strength is, of course, again 1/2. The last value sequence represents conjunction (&), in von Foorster´s words a "coalition", and the logical strength of the value sequence is in this case 3/4 since, compared with the equivalence relation the last value of the sequence has turned from 1 to 2 which adds one quarter the strength of the function.

The argument used by von Foerster has the great merit of showing that a super-additive principle of logical strength is already extant in classic formal logic (and so is its opposite of super-subtractivity in disjunction). But the history of traditional logic has shown that the form in which super-additivity manifests itself in simple conjunctive relations does not suffice to develop all the peculiar characteristics of totalities which we find displayed in systems of reasonably high complexity. This is why the history of formal Aristotelian logic is accompanied by an equally long history of dialectic (non-formal) logic. The latter was supposed to take up the logical problems, where formal logic, due to its specific limitation, had to drop them.[3]

It will pay to investigate the basic shortcoming of traditional formal logic. To put it in a nutshell: it excludes the subject of thought from the logical picture of the Universe.[4] Thus this picture is entirely "objective" in the full double meaning of the term. It goes without saying that the mental image of the Universe, thus obtained, does not describe it as a totality. A very important structural element is missing in this logical imagery: the indubitable power of the Universe to form subsystems which act as centers of objective reflection as well as of self-reflection. But since this property is excluded it stands to reason that the totalities of lower order which we encounter in biology, psychology, social sciences or history are also outside the scope of traditional logic. They are parts

3 The terms "traditional", "classic" and "Aristotelian" shall be used in this assay as applied and interpreted in: Gotthard Günther, *Idee und Grundriss einer nicht-Aristotelischen Logik*, Hamburg (Meiner) 1959.

4 An excellent description of this epistemological situation is given in E. Schrödinger, *Mind and Matter*, University Press, Cambridge 1959. See esp. p.51.

of the Universe and available for their description are only the very same logical elements and procedures which are applicable to the objective world in its entirety. This means they cannot be described as totalities either.

It will help to understand the epistemological situation of our traditional formal logic (including modern mathematical logic!) if we draw a diagram:

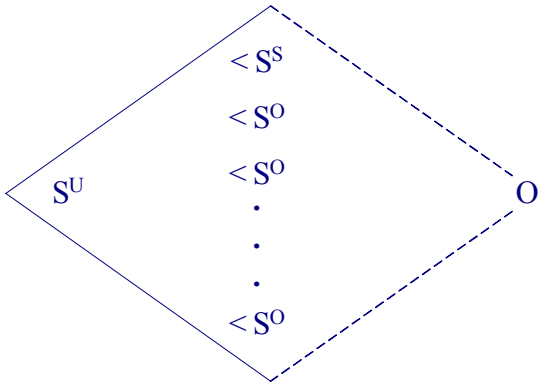

Fig_1

In this figure O means, of course, the objective world as reflected in the consciousness of a subject S··· . But since subjectivity is a phenomenon shared by an indefinite number of relatively independent centers of self-reflection and, moreover, only one of them may, for the purpose of developing a theory of thinking, be regarded as *the* subject who thinks whereas the others are thought of, we have to distinguish three different meanings of S···. We show this by writing: S^U, S^S and S^O. With S^U we indicate what in traditional logic is usually called universal subjectivity (Kant´s "Bewusstein überhaupt"). When we write S^S (or subjective subject) we refer to what is in a given process of thinking the actual subject of the mental event. All the other potential subjects of thought are, of course, relative to the designated one (S^S) objective subjects, i.e. possible objects of the reflection of S^S. In our figure they are indicated by S^O.

The classic theory of thinking as expressed in all our present systems of logic assumes that subject (S^U) and object (O) represent logically speaking an absolute dichotomy: what is not object is necessarily subject and what is not subject is correspondingly object. It is assumed that looking at the world all subjects form a closed phalanx confronting the object and since they are all – in some unexplained manner – parts of the universal subject (S^U) they will have a common basis of thought. Because if S^S agrees in its reflection of O with S^U then the resulting judgments of S^S will be binding for all S^O. It follows that the general (metaphysical) dichotomy between S^U and O is reflected in a second order dichotomy which separates S^U and S^S from S^O and O.

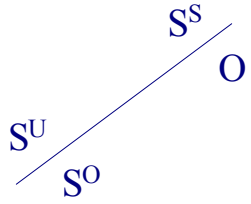

Fig_2

But since what is in the mental eye of the subjective subject (the self) only an objective subject (a thou) may in its turn become the thinker, Figure 2 is not complete, because S^U and S^O may also be dichotomically separated from S^S and O. Thus we obtain

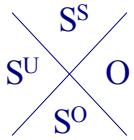

Fig_3

The pattern obtained in Figure 3 yields if we replace S and O by P and N (P for positive and N for negative), the well known table of two-valued negation:

Fig_4

The distinction between S^U and S^S resp. S^O which has disappeared in Figure 4 re-occurs later as difference between partial and total negation and reflects itself in the qualificational equivalences:

$$\begin{aligned} (x)f(x) &\equiv \sim(Ex)\sim f(x) \\ \sim(x)f(x) &\equiv (Ex)\sim f(x) \\ (x)\sim f(x) &\equiv \sim(Ex)f(x) \\ \sim(x)\sim f(x) &\equiv (Ex)f(x) \end{aligned}$$

which may be derived from the laws of the famous square of opposition.

In other words: the founding relation of all classic thought and its ultimate basis on which everything is built is an *exchange relation of absolute symmetry* between total affirmation and total negation.[5] Its most famous expression is Hegel´s terse remark at the beginning of his Dialectic logic: "Das reine Sein und das reine Nichts ist … dasselbe"[6]. A formalized equivalent of it is:

$$A \equiv \sim(\sim A)$$

which holds only in a two-valued system of logic where each value is the mirror image of the other.

There can be no doubt that the operational basis of classic logic is an exchange relation between subject and object or between a mapping process and that which is mapped. However, if we have a second look at Figure 2 or 3 we will notice that the complete symmetry of the exchange relation between S··· is guaranteed only by the introduction of the concept of a universal subject (S^U) which according to the metaphysical tradition of classic logic (e.g. Nicolaus Cusanus) is, ontologically speaking, identical with O.

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5 Hence the isomorphism of classic logic. Cf. Reinhold Baer, *Hegel und die Mathematik*, Verhandlungen des zweiten Hegel Kongresses vom, 18.-21. Okt. Publ. Tübingen 1932.

6 Hegel III (Meiner 1923) p. 67.

The modern scientist who tries to discover the formulas in which the code of the Universe is written is usually not aware of the basic ontologic assumptions which govern his mode of thinking. But they show up in his results just the same. Because if S^U is ultimately identical with O then his world picture will contain no traces of bona fide subjectivity – as Schrödinger has pointed out correctly. And if S··· and O represent an exchange relation of enantiomorphic equivalence then the basic laws of Nature must obey the principle of reflection-symmetry (parity). Whenever a phenomenon shows up which seems to display the structural features of non-parity there will be cogent reasons for a turn to more general principles of reasoning which explain the event again in terms of reflection-symmetry. These reasons will not only be strong, nay, they will be invincible as long as we stick to the ontologic tradition of classic logic and its principle of reflection-symmetry.

We are here not concerned with the fate of parity in the future development of physics but it must be pointed out that the concept of Totality should be ruled out as logically analyzable if parity reigns supreme in our theory of thinking. We have given the main reason above: if the relation between thought and its object is basically understood as a symmetric exchange relation the phenomenon of subjectivity disappears. But a "totality" in which everything is reduced to objectivity can never be total because something is missing.

A totality is, in Hegel´s terminology:

1) an iterated self-reflection of
2) a non-iterated self-reflection, and
3) a hetero-reflection.

If we permit, for the description of this structure, only logical operations which lead to reflection-symmetry then 1) is eliminated, and 2) and 3) turn out to be indistinguishable and logically identical … because 1) is nothing else but the capacity of keeping 2) and 3) apart.

However, if the concept of the universal subject, i.e. of 'Bewusstein überhaupt' (Kant), is eliminated the logical constraint to reduce everything to ultimate parity relations disappears. We will still have reflection-symmetry between S^S and S^O but not longer between S··· and O in general. In other words: it will turn out that the founding relation between subject and object or between Thought and Being is not a symmetrical exchange relation but something else. This is the point where the transition is made from formal classic logic of Aristotelian type to a theory of trans-classic, non-Aristotelian Rationality.

We begin by re-drawing Figure 1 omitting S^U and having the phalanx of the S^O replaced by a single S with the index O. We indicate the relations between S^S , S^O and O by arrows of four different shapes. According to the logical character of the relation an arrow will either be double-pointed or it will have one shaft or be double-shafted having either continuous or dotted lines. Figure 5 will then show the following configuration:

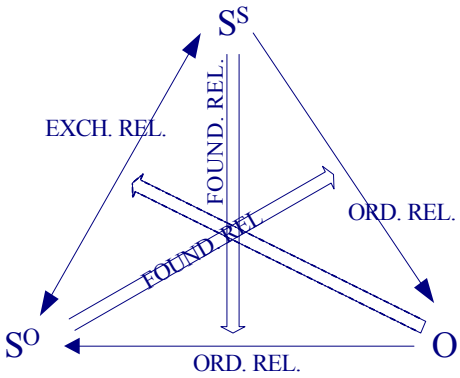

Fig_5

If S^S designates a thinking subject and O its object in general (i.e. the Universe) the relation between S^S and O is undoubtedly an *ordered* one because O must be considered the content of the reflective process of S^S. On the other hand, seen from the view-point of S^S any other subject (the Thou) is an observed subject and it is observed as having its place *in* the Universe. But if S^S is (part of) the content of the Universe we obtain again an ordered relation, this time between O and S^O. There remains the direct relation between S^S and S^O. This is obviously of a different type. S^O is not only the passive object of the reflective process of S^S. It is in its turn itself an active subject which may view the first subject (and everything else) from its vantage-point. In other words S^O may assume the role of S^S thus relegating the original subject, the Self, to the position of the Thou. And there is neither on earth nor in heaven the slightest indication that we should prefer one subjective vantage-point for viewing the Universe to another. In short, the relation between S^S and S^O is not an ordered relation. It is a completely symmetrical *exchange* relation, like "left" and "right". An ordered relation between different centers of subjective reflection cones into play only if we re-introduce the concept of a universal subject which contains all human "souls" as computing sub-centers.[7] Of the two relations we have so far considered, the exchange relation is symmetrical and the ordered relation represents non-symmetry.

There is, however, one more relation to be considered which combines in a peculiar way the aspects of symmetry and non-symmetry. In the previous two cases the members or arguments of the relation could be considered as unanalyzed units. Or to talk in terms of our diagram, the relations hold between

$$\begin{array}{lcl} S^S & \rightarrow & O \\ O & \rightarrow & S^O \\ S^O & \leftrightarrow & S^S \end{array}$$

as the corners of our triangle. What we still have to consider is the relation any of the three terms S^S, O and S^O may assume to the relation which holds between the other two

7 The other case, that the computing mechanisms of animals, plants or artifacts may be logically regarded as subsystems in a theory which describes the epistemological structure of human consciousness is not considered here. Considerable work has been done with regard to this problem in Cybernetics, but not on a purely *logical* level The interest of application to *physical* systems is always dominant. Cf. W. Ross Ashby, *An Introduction to Cybernetics*, New York 1956.

terms. From a purely combinational view-point three possibilities exist for a demanded relation … r^F … they are:

$$S^S\, r^F\, (O \rightarrow S^O)$$
$$O\, r^F\, (S^O \leftrightarrow S^S)$$
$$S^O r^F\, (S^S \rightarrow O)$$

From these we shall, for the time being at least, eliminate the second. It tells us nothing new. It describes only the situation we are familiar with from classic (two-valued) logic where all subjects S··· form, what we called earlier in this paper a "closed phalanx" excluding the object from themselves and thus obtaining an "objective" aspect of the Universe. Consequently $Or^F(S^O \leftrightarrow S^S)$ only informs us that if O develops its mirror image in S··· it will do so in dichotomic terms of positive and negative forming a strict exchange relation since S··· will be either S^S or S^O and a Tertium will always be excluded.[8] We have pointed out before that such an exclusion principle obviates our conceiving totalities in terms of traditional logic. Since the relation $Or^F(S^O \leftrightarrow S^S)$ is known to logic since the times of Aristotle and has its own specific properties we distinguish its graphic representation from the other two by having drawn it with dotted lines.

However, the other two relations of the type …r^F… have so far not obtained a legitimate place in formal logic. They define the way in which an individual consciousness (as a logical subject) may establish its position confronting the world. Formally speaking it is the relation any of the two realizations of S···, namely S^S or S^O, may have toward the connection of the other S··· and O. We call this the *founding* relation (r^F) because by it, and only by it, a self-reflective subject separates itself from the whole Universe which thus becomes the potential contents of the consciousness of a Self gifted with awareness. In contrast to it the classic relation $Or^F(S^O \leftrightarrow S^S)$ is still a founding relation – but not for consciousness. Not a self-reflective subject but only the *content* of the consciousness of a potential subject is established by it.

In Figure_5 the founding relations for subjectivity are indicated by the double-shafted arrows which issue from S^S and S^O and hit the center of the opposite side of the triangle. These arrows illustrate in diagrammatic form the relations between consciousness as a self-reflective activity and the world in general. The world is always *both* O (bona fide objectivity) and S^O subjects viewed as part of the objective world … where S··· is always excluded only as S^S. This last statement seems to be contradicted by our figure because the arrow issuing from S^O seems to point to a world which includes S^S and O. This is the unavoidable fault of a still picture. An adequate representation would demand a moving picture in which the double shafted arrow would oscillate between S^S and S^O. One should not forget: what is in our diagram S^O may at any time assume the role of S^S, thus relegating the latter to the logical position of S^O. Let us repeat that S^S and S^O constitute the exchange relation between subjectivity as the Self and the other subject which appears to the Self as the Thou. For any given logical position only one

8 See Figure I

of the two double-shafted arrows represents actualization of a center of self-reflection. Since such actualization requires all *three* components S^S , S^O and O it is impossible if we have located the center in S^S to find it also in S^O. But it has no fixed status in S^S and it may be shifted to S^O. Fichte calls this "die Duplizität im Ich" because, as he puts it, such a center of self-reflection can neither be fully identified as an existing entity (als seiend) nor as a structural principle of active organization (als Prinzip). This is the Duplicity of the Self.[9]

What we have so far ignored in our contraposition of S^S and S^O is the fact, well known to all of us, that no Ego, or Self exists in solipsistic splendour and that this universe of ours permits the coexistence of an indefinite number of centers of self-reflection who all claim to be thinking Egos comprising the total realm of Being as potential contents of their awareness. It is obvious, therefore, that the exchange relation is an *exclusive* disjunction on a level of reflection which is identified with the logical position of S^S.

But an impartial observer, S^{SS} , who assumes his place neither in S^S or S^O but "outside" of Figure 5 will come to a different conclusion. He will still concede the existence of a disjunctive relation between two subjects but to him this disjunction must be inclusive. He is forced to admit that two concurring S··· may both be S^S although relative to him both will be S^O as long as he is claiming the exalted position of an S^S of higher reflexive capacity.

But this claim also extracts from the "outside" observer, S^S an interesting admission. He will state that, seen from his vantage point, the inclusive disjunction does not only hold in the case of:[10]

$$S^S r^F(O \rightarrow S^O) \;.\vee.\; S^O r^F(S^S \rightarrow O) \qquad (1)$$

but also in the other two cases:[11]

$$S^O r^F(S^S \rightarrow O) \;.\vee.\; Or^F(S^S \leftrightarrow S^O) \qquad (2)$$

$$S^S r^F(O \rightarrow S^O) \;.\vee.\; Or^F(S^S \leftrightarrow S^O) \qquad (3)$$

provided, of course, that he uses a two-valued logic. But in doing so he realizes by self-reflection that he has committed a momentous logical mistake. Since in classic logic only two values are available for the determination of the distinction between subject and object, it is impossible to describe the *triadic* relation between the subjective subject; the objective subject and the object.

The common fallacy committed by logicians who reason along traditional lines is that if subject and object are different it is sufficient to assign different values to them. But since the structure of classic negation represents a symmetric exchange relation and since there can be no preference to assign a definite value to S··· or to O, it is

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9 Cf. Joh. G. Fichte: *Die Tatsachen des Bewusstseins*, Posthumous Works (ed. J. H. Fichte, vol. I) p. 573. Fichte also mentions a second duplicity of the contents of consciousness.

10 … rF…and …→… will both be interpreted as material implications and … ↔ …as negated equivalence or exclusive alternation.

11 For the transition of O to S^O note Hegel´s remark: "…im Lebendigen schlägt das *Objekt* in das *Subjekt* um …", Hegel (ed. Glockner) X, p. 263.

impossible to distinguish the subject from the object by saying, for instance, that the positive value ultimately designates the object (because we describe the Universe in affirmative statements) and that the negative value refers to the subject. Although there can be no doubt that the existence of negational processes is a symptomatic index for the presence of subjectivity in the Universe, it is not one or the other value which points to the subject but their mutual relation which displays "Reflexionsidentität" in contrast to the one-valued, stable and irreflexive identity which is incorporated in the bona fide object.

Nevertheless, it is indeed possible to determine the distinction between subject and object by logical values. Not by assigning *another* value to the subject but by engaging *two* values for the designation of *one* identity. And since we can think at least of one more theme beyond a) object, b) subject namely "reality" as the ultra-conscious context c) in which object and subject cooperate we would have to allot three values for the identity theory of c). In the case that we may be able to conceive something of even higher logical order, the difference between it and everything else would be determined by a tetradic structure of values.

The following table (II) will illustrate this relation between object designation, logical theme, value differential and n-valued logical system:

theme				
object	non-object		value-differential	log. value-system
1	1		0	2
1	2	hierarchy	1	3
1	3	of	2	4
1	4	themes	3	5
…	…		…	…

(II)

Since the object, completely isolated from the subject, is designated, by one and only one value, the object column only repeats this number. In classic logic the numerical difference between the values for the object and those which designate the subject – or anything else for that matter – is zero. The third column therefore starts with 0. This informs us that the only way to think of a subject or any system gifted with self-reflection, is to conceive it as an object – which means *without* self-reflection. In other words: the first theoretical approximation to the problem of subjectivity is offered in a three-valued logic. Here again one value designates the object, but two are left over for everything which is not an object. The numerical difference between the values assignable to the object and non-object is now 1. Something can now be said (in terms of logical structure) about the non-object which would differ from all statements about bona fide objects.[12]

12 The reader´s attention should be drawn to the significant fact, that the numbers in the centre column of Table II are the numbers of rejection values in ascending value systems. Cf. G. Günther: *Cybernetic Ontology and Transjunctional Operations*, Self-Organizing Systems 1962 (ed. Yovits, Jacobi, Goldstein) p. 313-392 (Washington 1962).

Our ideal observer who contemplates the relations between subject and object as illustrated in the triangle of Fig. 5 must ultimately arrive at the conclusion that table (II) is applicable in his case. *He cannot differentiate between himself and the triangle unless he assigns to himself a logical value which does not occur in the triangle*. But what is sauce for the goose is sauce for the gander. Our observer expects that S^S in the triangle is capable of differentiating between itself and O. Consequently he has to concede that S^S in contradistinction to O possesses an additional value. Since O is described in a two-valued system, the description of the triangle requires a three-valued logic. Finally this description is the content of the consciousness of our ultimate observer who must consequently reason with four-valued structures.

However, as soon as our observer realizes that the founding relations in Fig. 5 obey the laws of a three-valued logic, he realizes that not all the inclusive disjunctions which he established in the formulas 1), 2) and 3) are analytic formulas and generally valid. He will find that only 1) still holds and that the disjunctive relation in S··· between S^S and S^O is indeed basic and invariant to a transition into a higher-valued system. With regard to 3) he will discover that its general validity has completely disappeared. Formula 2), on the other hand, has assumed a peculiar equivocality. Since a three-valued logic operates with five negational states[12] – where two-valued logic uses just one – an exchange-relation may be interpreted in five different ways. In the case of three of them formula 2) will be as valid as 3); i.e. for all possible states of the system of Fig 5. In the case of two others formula 3) will be invalid if the system O, S^O, S^S assumes the following values: classic negation for O and the irreflexive value for S^O as well as S^S. This is a most significant result!

Unfortunately the scope of this paper precludes an interpretation and discussion of such details no matter how important they are. This investigation intends only to show that the concept of Totality or Ganzheit is closely linked to the problem of subjectivity and trans-classic logic and that it is based on three basic structural relations:

an *exchange* relation between logical positions
an *ordered* relation between logical positions
a *founding* relation which holds between the member of a relation and a relation itself.

It may be said that the hierarchy of logical themes as indicated in table (II) represents an hierarchy of implicational power. All themes have in common that they are self-implications; they imply themselves. However the first theme (objective existence) implies only itself and nothing else. In this respect it differs from any succeeding theme which implies itself as well as all subordinated themes. For this reason it is proper to call the initial theme "irreflexive" and all the following "reflexive". Irreflexivity means that something we think of is only an implicate but not an implicand for something else. On the other hand if we refer logically to reflexivity we mean that our (pseudo-)object of thought is an implicand relative to a lower order and as well an implicate relative to a theme that follows it in the hierarchy of table (II).

We are now able to establish the fundamental law that governs the connections between *exchange*-, *ordered*- and *founding*-relation. We discover first in classic two-valued logic that affirmation and negation form an *ordered* relation. The positive value implies itself

and only itself. The negative value implies itself *and* the positive. In other words: affirmation is never anything but implicate and negation is always implication. This is why we speak here of an *ordered* relation between the implicate and the implicand. The name of this relation in classic two-valued logic is – inference.

It is now necessary to remember that the possibility of coexistence of two independent subjects (I and Thou) in the Universe is based on an *exchange* relation between equipollent centers of reflection. Moreover, these subjects are all capable of being implicands. More objects do not operate inferentially. That means they do not imply anything else.

If we now consider the *founding* relation in which a subject constitutes itself as diametrically posed relative to all objects and the *total* objective concept of the Universe we will discover that this relation represents an interesting synthesis of *exchange* and *order*. The *founding* relation is in itself an *exchange* relation in so far as the linking subject (S^S) may assume the logical position of the other subject which is thought of (S^O). S^O may in its turn assume the rank of S^S. Any two centers of subjective reflection of the same order mutually imply each other. But such an exchange does not operate between S··· and O. As we pointed out before: the bona fide object cannot infer the subject and by doing so usurp the role of a subject. If it could it would imply that subjects are irreflexive entities which for a subject is a contradictio in adjecto.

It follows that the relation between implicate and implicand has two different aspects: between two subjects this relation assumes the role of a symmetrical *exchange*. Between subject and object it appears however as an *ordered* relation. The *founding* relation is therefore also an ordered relation. Or to put it differently: the founding relation is a combination of *exchange* and *order*. What is the implicand (S^S) may become the implicate *not relative to* O but to our impartial observer S^{SS}. We might say that the *founding* relation is a concatenation of sequences of *exchange* and sequences of *ordered* relations.

The diagram of Fig._6 will illustrate what we mean:

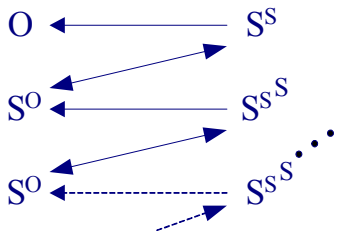

Fig_6

Fig._6 indicates a sequence of single-pointed and a second sequence of double-pointed arrows such that a single-pointed arrow always alternates with a double-pointed one. A concrete example of what the figure illustrates is the father-son relation. This is first an ordered relation. But the son can also become a father. In this sense father-son is also an exchange relation. But the son does not acquire the status of father relative to his own father but relative to the grandson of his father. In abstract terms: what is member (or argument) of the ordered relation $O \leftarrow S^S$, namely S^S, may become an argument of an exchange relation not relative to O but relative to S^{SS} which implies this *exchange* $S^S \leftrightarrow S^O$.

Thus we may say: the *founding*-relation is an *exchange*-relation based on an *ordered*-relation. But since the *exchange*-relations can establish themselves only between *ordered* relations we might also say: the *founding*-relation is an *ordered* relation based on the succession of *exchange*-relations.[13] When we stated that the *founding*-relation establishes subjectivity we referred to the fact that a self-reflecting system must always be:

self-reflection of (self-and hetero-reflection).

As Hegel pointed out in his dialectic logic one and a half centuries ago, the opposition of hetero- and self-reflection is not a parity relation because it requires an iteration of self-reflection in contrast to the non-iterative character of hetero-reflection. It follows as was pointed out above, that one value is sufficient to designate in hetero-reflection but two values are required – apart from the value for object-designation – to separate self-reflection from the object. This is confirmed by the character of the *founding*-relation. Table (VI) clearly shows that it requires a minimum of three values for its own establishment.

But the introduction of a third value generates a new principle of superadditivity. In von Foerster´s case the super-additivity concerned only the increase of the classic negative value in a truth function. In the case of the *founding*-relation an increase in the number of two-valued systems is concerned. All "truth functions" of a three-valued system are compositions of three two-valued systems represented by the values 1+2, 2+3 and 1+3. For each value we might further add, we would obtain a new super-additive increase of (two-valued) systems. We can determine this increase in analogy to von Foerster´s formula $\Phi(x+y) > \Phi(x)+\Phi(y)$ by introducing the expression

$$\Phi(z) = 1/2z(z-1)$$

If z is composed of two terms, a and b, representing the poly-validity of two logical systems we have

$$z = a + b$$

The super-additivity we are looking for is then demonstrated by

$$1/2(a+b)\ (a+b-1) > 1/2a(a-1) + 1/2b(b-1)$$

where clearly the left hand side of this inequality exceeds the right hand side by

$$ab$$

This is nothing other than the cross-term interaction of a and b.

Thus a four-valued system which our impartial observer S^{SS} would require must consist of 6 two-valued systems of reflection. In the case of a five-valued logic this number would increase to 10 two-valued subsystems.

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13 The author found that a practically identical formal pattern of the relation between symmetrical exchange and order was discussed in an earlier book by Karl Heim, *Das Weltbild der Zukunft*, Berlin 1904, esp. p. 35ff.; Heim calls its pattern "Grundverhältnis". However, it was developed for a very different purpose and it does not assume our initial state O.

The logical prototype of all totalities (Ganzheiten) is the system of consciousness. We know this at least since the advent of the Critique of Pure Reason. But consciousness involves as we have seen a *synthesis*, of the two most basic relations in logic: the symmetrical *exchange* of values and the hierarchal *order* of values. *Exchange* and *order* are combined in a new codifiable principle which we call the *founding* relation. This principle establishes the totality of consciousness but since it is entirely formal it also governs the structural laws of any totality we may conceive as such.

Already in 1950 L. von Bertalanffy wrote in an essay on General Systems Theory "that many concepts which have often been considered as anthropomorphic, metaphysical or vitalistic, are accessible to exact formulation." [14] However, what is still missing in General Systems Theory is the representation of such concepts as exemplifications of a universal formal theory of totalities grounded in the concept of logical value and its operation by affirmation and negation. This paper tries to make a contribution in this direction following the example given by Hegel.

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14 Cf. L. v. Bertalanffy, *An Outline of General Systems Theory*, Brit. Journ. f. the Philos. of Science I, 2 (Aug. 1900) p. 134-165.

Gotthard Günther

DIE HISTORISCHE KATEGORIE DES NEUEN

DIE HISTORISCHE KATEGORIE DES NEUEN [1)]

Die Gestalt Hegels, so wie sie in seinem Werke uns erscheint, steht in einem zwiespältigen Licht. Auf der einen Seite war Hegel ein liebevoller und ehrfürchtiger Bewahrer des Alten; auf der andern Seite hat kein Philosoph vor ihm das philosophische Denken so weit in neue Dimensionen der Reflexion vorgetrieben, daß die Verbindung zum Alten oft gefährdet, wenn nicht gar verloren zu sein scheint. Die dreifache Bedeutung des Hegelschen Begriffs des "Aufhebens" beschreibt die Dialektik der Situation. Das Alte ist im Neuen aufgehoben insofern, als es in ihm vernichtet und vergessen ist. Aber in einem tieferen Sinne ist es im Neuen bewahrt und erhalten. Und mehr noch: insofern als es erhalten und im Neuen selbst neu geworden ist, bedeutet das Aufgehobensein schließlich ein Emporgehobensein und eine Verklärung in den Strahlen der Reflexion.

In dieser dialektischen Entgegensetzung zum Alten enthüllt sich uns die Kategorie des Neuen in drei verschiedenen Gestalten je nach dem ontologischen Ort, an dem sie uns erscheint. Am Anfang der Geschichte des Absoluten ist das Neue nur ein unerfülltes Versprechen, die bloße Möglichkeit eines Kommens, auf das man hofft. Im Fortgang der Welthistorie ist das Neue das Revolutionäre und Gefährdende, das alte Gefäße und Formen zerbricht, und schließlich, im eschatologischen Rückblick auf die im Hier und Jetzt jeweilig vollendete Geschichte, enthüllt sich das Neue als die Erfüllung und Versöhnung der dialektischen Gegensätze, an denen das Alte zugrunde und damit, wie Hegel sagt, in seinen Grund zurück gegangen ist.

THE HISTORICAL CATEGORY OF THE NEW [*)]

The figure of Hegel appearing to us in his work stands in an ambiguous light. On the one hand Hegel was a loving and reverent keeper of the old; on the other hand no philosopher before had driven philosophical thought so far into new dimensions of reflection, so that the connection to the old often seems endangered, if not wholly lost. The threefold meaning of the Hegelian concept "Aufheben"[2)] describes the dialectic of the situation. The old is "aufgehoben"[3)] in the new in so far as it is destroyed by and forgotten in the new. But in a deeper sense the old is preserved and maintained in the new. Moreover: in so far as the old is maintained in the new and in the new has itself become new, it is elevated and transfigured in the rays of reflection.

In this dialectical opposition to the old the category of the new is revealed to us in three different forms, each according to the ontological place in which it appears to us. At the beginning of the history of the absolute the new is but an unfulfilled promises the mere possibility of the something to come, for which one hopes. In the progress of world history the new is the revolutionary and dangerous that breaks apart old forms and restraints, and, finally, with an eschatological backward glance at history - complete at any moment in the here and now - the new reveals itself as the fulfillment and reconciliation of the dialectical oppositions in which the old has perished and, as Hegel says, returned to its ground.

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*) English Translation by Richard H. Howe and E. von Goldammer

2) "Aufhebung" translated as "sublation"

3) "aufgehoben" translated as "sublated"

Die Sprache, die wir in diesen einleitenden Sätzen gesprochen haben, ist - wie auch Hegels Text des öfteren - bildhaft, romantisierend und wenig geeignet zur wissenschaftlichen Analyse. Wir wollen uns deswegen fragen, ob es möglich ist, den Hegelschen Begriff des Neuen einer strukturtheoretischen Analyse zu unterwerfen, in der das soweit nur hermeneutisch Verständliche sich auf exakte analytische Begriffe zurückführen läßt. Freilich, bevor wir an diese Aufgabe gehen, müssen wir feststellen, was Hegel selber zum Thema sagt. In Band IX der Originalausgabe finden wir in der Einleitung zu den VORLESUNGEN ÜBER DIE PHILOSOPHIE DER GESCHICHTE auf S. 67 den folgenden Passus: "Die Veränderungen in der Natur, so unendlich mannigfach sie sind, zeigen nur einen Kreislauf, der sich immer wiederholt; in der Natur geschieht nichts Neues unter der Sonne, und insofern führt das Vielförmige ihrer Gestaltungen eine Langeweile mit sich. Nur in den Veränderungen, die auf dem geistigen Boden vorgehen, kommt Neues hervor." Neues in einem grundsätzlichen und prinzipiellen Sinne gibt es für Hegel, wie es scheint, also nur in der Geschichte, denn er unterscheidet in derselben Einleitung ausdrücklich ein natürliches und ein geistiges Universum (S. 35). Das letztere ist für ihn die Weltgeschichte.

Entwicklungen und Veränderungen in der Natur folgen nach Hegel "einem inneren unveränderlichen Prinzip" und finden auf eine "unmittelbare, gegensatzlose, ungehinderte Weise" statt. Emphatisch fährt er dann fort: "Im Geist aber ist es anders ... er hat sich selbst als das wahre feindselige Hindernis seiner selbst zu überwinden; die Entwicklung, die in der Natur ein ruhiges Hervorgehen ist, ist im Geist ein harter unendlicher Kampf gegen sich selbst" (S. 68). Diese Unterscheidung ist Hegel so wichtig, daß er im nächsten Abschnitt noch einmal darauf hinweist, daß die Entwicklung der historischen Epochen nicht dasselbe ist wie das "harm- und kampflose bloße Hervorgehen" (S. 69), das nach seiner Meinung die Evolution des natürlichen Lebens kennzeichnet. Hegel resümiert dann seine geschichtsphilosophischen Gedanken mit der bündigen Feststellung: "Die Weltgeschichte stellt ... den Stufengang der Entwicklung des

The language that we have spoken in these introductory sentences is - as is Hegel´s own text more often than not - metaphoric, romanticizing, and little suited to scientific analysis. For that reason we want to ask whether it is possible to submit the Hegelian concept of the new to a structural-theoretic analysis in which that which so far was to be understood only hermeneutically can be derived from exact analytic concepts. But before we proceed with this task we must establish what Hegel himself had to say on this theme. In volume IX of the first edition we find in the introduction to the *Lectures on the Philosophy of History* on page 67 the following passage: "The changes in nature, however, infinitely manifold they are, describe but a circle that repeats itself ever and again; in nature there is nothing new under the sun, and to that extend the play of her forms has a certain boredom to it. Only the changes that come forth on the ground of spirit does anything new appear." So in a fundamental and principles sense it seems that for Hegel there is newness only in history, for in the same introduction he expressly distinguishes a natural and a spirited universe (p.35). The latter is for him world history.

According to Hegel developments and changes in nature follow "an internally unchanging principle" and occur in an "immediate unhindered manner free of oppositions". He then continues emphatically: "But with spirit it is otherwise ... spirit has itself to overcome as the true inimical hindrance to itself; development, which in nature is a tranquil process, is for spirit a hard, unending struggle against itself" (p.68). This distinction is so important for Hegel that in the next section he once again refers to the fact that the development of the historical epochs is not the same as the "harmless process free of struggle" (p.69) that in his opinion characterizes the evolution of natural life. Hegel then summarizes his historico-philosophical thoughts with the conclusive statement: "World history represents ... the sequence of stages

Prinzips, dessen Gehalt das Bewußtsein der Freiheit ist, dar" (S. 70).

Der Unterschied von Natur und Geist liegt also gemäß den Vorlesungen über die Philosophie der Geschichte darin, daß alle Entwicklung in der Natur auf dem Boden eines "inneren unveränderlichen Prinzips", das keine echten, d. h. prinzipiellen Gegensätze aufkommen läßt, statthat; daß Geschichte aber eine stufenartige Entwicklung eines Prinzips impliziert. Die Kategorie des Neuen, als eminent historische, steht also in wesentlicher Verbindung mit der Veränderung eines allgemeinen Prinzips.

Damit hierüber nur kein Mißverständnis bestehe, führt Hegel auch einen unechten Begriff des Neuen an. Er erwähnt die Legende vom Phoenix als Sinnbild "von dem Naturleben, das ewig sich selbst seinen Scheiterhaufen bereitet und sich darauf verzehrt, so daß aus seiner Asche ewig das neue, verjüngte, frische Leben hervorgeht" (S. 90). Nachdem Hegel dieses Bild als nicht sachgemäß abgelehnt hat, fährt er kontrastierend fort: "Der Geist, die Hülle seiner Existenz verzehrend, wandert nicht bloß in eine andere Hülle über, noch steht er nur verjüngt aus der Asche seiner Gestaltung auf, sondern er geht erhoben, verklärt, ein reinerer Geist aus derselben hervor" (S. 90f.). Von Erhebung und Verklärung kann allerdings in der Monotonie der ewig gleichen Wiederkehr des Phoenix nicht die Rede sein. Seine Auferstehung ist bloßer Naturvorgang. Sie ist die Selbstwiederholung eines unveränderlichen Prinzips, das auch durch den Tod in nichts Höheres transformiert wird. Darum ist ein solcher Tod nach Hegel irrelevante Vernichtung des vom Allgemeinen abgetrennten Einzelnen. Über diesen Tod lesen wir in der PHÄNOMENOLOGIE DES GEISTES, daß er "keinen inneren Umfang und Erfüllung hat" (II, S. 446). Diesen natürlichen "platten" Tod sterben Individuen und wohl auch Völker, obwohl die letzteren, wenn sie ihre historische Mission erfüllt haben, gelegentlich weiter dauern können. Eine solche Fortdauer aber ist, so bemerkt Hegel, "eine interesselose unlebendige Existenz ... eine politische Nullität und Langeweile. Wenn ein wahrhaft allgemeines Interesse entstehen sollte, so müßte der Geist eines

of development of the principle whose content is the consciousness of freedom" (p.70)

In accordance with the lectures or the philosophy of history the distinction between nature and spirit is that in nature all development takes place on the ground of an "internally unchanging principle" that allows no genuine, i.e., principled oppositions to arise; but that history implies a staged development of a principle. So the category of the new, as an eminently historical one, stands in an essential relations to the change of a general principle.

So that no misunderstanding might arise about this, Hegel also cites a false concept of the now. He mentions the legend of the Phoenix as symbol "of natural life that eternally prepares its own funeral pyre end then consumes itself so that out of its ashes the new, youthful, fresh life may eternally arise" (p.90). After Hegel rejects this image as inappropriate he continues by way of contrast: "Spirit, consuming the shroud of its own existence, does not merely wander into another shroud, not does it merely arise youthful and renewed from the ashes of its form, rather it arises from them elevated, transfigured, a purer spirit" (p. 90ff). There is nothing of elevation and transfiguration in the monotony of the eternally selfsame return of the Phoenix. Its resurrection is a mere natural event. It is the self-repetition of an unchanging principle that even through death is not transformed into anything higher. So according to Hegel such a death is an irrelevant destruction of the particular served from, the general. About this death in the PHENOMENOLOGY OF SPIRIT we read that it "has no inner range and content" (p. 446). Individuals and maybe nations die this natural "trivial" death although nations sometimes continue to exist if their mission is fulfilled. Such a continuance, however, is an "indifferent unanimated existence ... a political mere cipher and boredom. If a real general interest should be born the spirit of the nation should develop the will for

Volkes dazu kommen, etwas Neues zu wollen, - aber woher dieses Neue? es wäre eine höhere, allgemeinere Vorstellung seiner selbst, ein Hinausgegangensein über sein Prinzip, - aber eben damit ist ein weiter bestimmtes Prinzip, ein neuer Geist vorhanden" (IX, S. 93).

Nun macht Hegel aber einen subtilen Unterschied zwischen dem natürlichen Tod, sei es eines Individuums oder eines Volkes, und dem Untergang einer Gruppe als Träger und Repräsentant eines historischen Prinzips. Ein gesellschaftlicher Verband, der von einem solchen Prinzip beseelt ist, existiert nicht nur in der Gegensatzlosigkeit natürlicher, sinnlicher Existenz, sondern er hat, wie Hegel sagt, auch Existenz als Gattung. Gattung aber ist das, was einen prinzipiellen Gegensatz in sich erträgt. Bloße Desintegration des Gegensatzes produziert den natürlichen Tod, der nichts weiter als bis zum äußersten getriebene Gegensatzlosigkeit ist. Aber während eine solche Auflösung für die Individualexistenz das unwiderrufliche Ende bedeutet, ist der Tod für die Gattung die unerläßliche Bedingung für den Anfang von etwas Neuem. Dazu bemerkt Hegel in seiner Ästhetik: "Der Tod hat eine doppelte Bedeutung; einmal ist er das selbst-unmittelbare Vergehen des Natürlichen, das andermal der Tod des nur Natürlichen und dadurch die Geburt eines Höheren, des Geistigen, welchem das bloß Natürliche in der Weise abstirbt, daß der Geist dies Moment als zu seinem Wesen gehörig, an sich selbst hat" (X, 1; S. 450).

So weit haben wir uns darauf beschränkt, im Rahmen von Zitaten die wichtigsten Termini zu sammeln, die Hegel mit seinem Begriff des Neuen assoziiert. Es sind dies hauptsächlich "Veränderung", "Geist", "Gegensatz", "Prinzip", "Stufengang", "Tod" und "Auferstehung". Die Gewichtigkeit dieser Termini, die alle systematische Relevanz in der Hegelschen Philosophie haben, deutet darauf hin, daß unter der Kategorie des Neuen ebenfalls etwas Gewichtiges und Fundamentales zu verstehen ist. Es erübrigt sich, darauf hinzuweisen, daß, wenn Hegel vom Neuen spricht, er nicht solche Belanglosigkeiten wie neue Kleider oder neue Transportmittel meint. Wir fühlen uns zwar berechtigt, wenn wir von der biologischen Entwicklung der Organismen re-

developing something new, - but where is the new coming from? It would have to be a higher, a more general imagination of its own, an excess of its own principle, - but then a certain principle, a new spirit exists" (p. 93).

Hegel makes a subtle distinction between the natural death of an individual or a nation on one side and the decline of a group as subject and representative of an historical principle. A society animated by such a principle does not only exist within the oppositionlessness of a natural sensuous existence but exists - according to Hegel - as a genus. Genus, however, means something which in principle bears opposition. Any disintegration of oppositions produces the natural death which is nothing but the extreme oppositionless state. While such decomposition is the irrevocable end of any individual existence, death is absolutely essential for any genus as the beginning of the new. Hegel notes in his aesthetics: "Death has a double meaning: first, it is the self-immediate dying of the nature, and second it is the death of the naturalness only in connection with the birth of the higher - the spirit -, from which the pure naturalness dies off so that the spirit takes this moment as its own nature" (p. 450).

So far we confined ourselves in quoting in order to collect the most important concepts which Hegel associates with the new. These are given mainly by "change", "spirit", "opposition", "principle", "sequence of stages", "death" and "resurrection". The importance of these terms which are of systematic relevance in Hegel´s philosophy points to the fact that the category of the new also has to be regarded as important and fundamental. Needless to say that Hegel does not speak about the new with regard to such trivialities as new clothes or transportation. Although we feel legitimated to speak about new genus within the context of biological evolution, Hegel´s use of the term "new", however, is much more rigorous and even excludes such

den, zu sagen, daß im Laufe der Zeit neue Tiergattungen aufgetreten sind. Aber Hegels Gebrauch des Terminus "neu" ist so rigoros, daß auch diese Bedeutung ausgeschlossen werden muß, denn in der Natur geschieht ja - so wie er wenigstens behauptet - nichts Neues.

Wenn wir uns nun endlich der Frage zuwenden, ob und wieweit sich die Hegelsche Kategorie des Neuen strukturtheoretisch präzisieren läßt, dann fällt uns auf, daß die acht von uns erwähnten (und evtl. vermehrbaren) Fundamentalbegriffe, die Hegel mit der Kategorie des Neuen verbindet, sich in zwei Gruppen, wie in der folgenden Tafel, anordnen lassen:

säkular	mythologisierend
Veränderung (im Kreislauf)	Natur
Prinzip	Geist
Gegensatz	Tod
Stufe	Auferstehung

Wie man sieht, haben die Termini auf der linken Seite der Tafel wesentlich strukturtheoretisch-formalen Charakter. Die auf der rechten Seite bezeichnen nicht-säkularisierte Mythologeme. Jedem Begriff auf der rechten Seite entspricht also eine gewisse Struktureigentümlichkeit auf der linken - obwohl niemand ernsthaft behaupten kann, daß unsere Idee von 'Natur' damit erschöpft ist, daß wir stattdessen von kreislaufförmiger Veränderung sprechen.

Andererseits drängt das Verhältnis von linker und rechter Seite uns die folgende Überlegung auf: Wenn die Termini auf der linken Seite wenigstens den Anfang einer Formalisierung und Säkularisierung der Mythologeme bedeuten, dann sollte es möglich sein, einen solchen Prozeß der Formalisierung solange fortzusetzen, bis alle Mythologeme auf der rechten Seite - und andere, die wir in unsere Tafel eintragen könnten - als entweder elementare oder komplexe Struktureigenschaften unserer empirischen Wirklichkeit entlarvt sind.

Daß ein solcher Säkularisierungsprozeß einer älteren Mythologie in der Hegelschen Philosophie wirksam ist, daran kann kaum ein Zweifel bestehen. Auch läßt sich kaum bestreiten, daß die Kate-

a meaning because according to Hegel nothing new happens in nature.

If now we finally turn to the question of whether - and to what extent - the Hegelian category of the new can be made precise structurally-theoretically, then it occurs to us that the eight (more if needs be) fundamental concepts mentioned by us that Hegel connects with the category of the new can be arranged into two groups, as in the following table:

secular	mythologizing
change (circular)	nature
principle	spirit
oppositon	death
stage	resurrection

As can be seen, the terms on the left side of the table have an essentially structural-formal character. Those on the right side designate unsecularized mythologems. So every concept on the right side corresponds to a certain structural property on the left side - although no one could earnestly assert that our idea of "nature" is exhausted by our saying "circular change" instead.

On the other hand the relation of the left and right sides brings us to the following consideration: if the terms on the left side signify at least the beginning of a formalization and secularization of the mythologems, then it should be possible to continue such a process of formalization until all mythologems on the right side - and others that we could bring into our table - are unmasked as either elementary or complex structural properties of reality.

There can scarcely be any doubt that such a secularization process of an older mythology is at work in the Hegelian philosophy. And it can scarcely be

gorie des Neuen davon betroffen ist, obwohl für uns Heutige das Wort, wenn überhaupt, nur schwache metaphysische oder mythologische Assoziationen mit sich trägt. Aber wir wollen nicht vergessen, daß Hegels These, daß in der Natur nichts Neues geschieht, ein Zitat aus dem Prediger Salomo ist, und daß der Terminus auch sonst in der Bibel häufig in einem fundamentalen Sinne gebraucht wird. Es sei nur an den Anfang des 21. Kapitels der Offenbarung Johannis erinnert, "Und ich sah einen neuen Himmel und eine neue Erde; denn der erste Himmel und die erste Erde verging, und das Meer ist nicht mehr. " Hegels Assoziierung des Terminus "neu" mit "Prinzip" und "Stufe" z. B. enthält zwar den Ansatz einer solchen Säkularisierung, die über die biblische Tradition hinausgeht, aber auch nicht mehr.

Wir wollen jetzt diesen Ansatz um einen Schritt weiter treiben und fragen uns deshalb, was es bedeuten kann, wenn Hegel behauptet, daß die subalternen - nichts wirklich Neues produzierenden - Veränderungen, deren die Natur fähig ist, auf einer Gegensatzlosigkeit beruhen. Nun ist es ganz selbstverständlich, daß in j e d e r Veränderung irgendwelche Unterschiede und damit relative Gegensätze involviert sind. Hegel muß also zwei Gegensatztypen unterscheiden. Und er tut das in der Tat, wie allgemein bekannt ist. Funktionell charakterisiert er diese Gegensatztypen durch die Unterscheidung von partieller und totaler Negation.

Dabei fügt aber Hegel, wie ebenfalls bekannt, der ersten klassischen Negation mit ihrer partiellen und totalen Variante noch seine berühmte 'zweite Negation' hinzu. Zum Zwecke der Klärung des gegenseitigen Verhältnisses dieser beiden Negationen wollen wir ein neues Begriffspaar einführen, das wir mit den Termini ´Kontexturalität´ und 'Diskontexturalität' bezeichnen. Was eine Kontextur ist, wollen wir zuerst an einigen einfachen Beispielen erläutern: Wenn wir vom Sein-überhaupt sprechen, so meinen wir damit einen totalen systematischen Zusammenhang, der in sich geschlossen ist, also eine Kontexturbildet, die sich als solche von dem abgrenzt, was Hegel das reine Nichts nennt. Alle theoretischen Mittel, derer man sich innerhalb eines solchen kontexturellen Zusam-

contested that the category of the new is struck by that process, although for us today the word bears, if any at all, only weak metaphysical or mythological associations. But we do not want to forget that Hegel's thesis that nothing new happens in nature is a quotation from Ecclesiastes, and the term is often used elsewhere in the Bible in a fundamental sense. Just recall the beginning of the 21st chapter of the Revelation of St. John, where it reads: "And I saw a new heaven and a new earth: for the first heaven and the first earth passed away, and there was no more sea." Hegel's association of the term "new" with "principle" and "stage" for example contains to be sure the start of such a secularization, but then nothing more than a start.

We now want to drive this start further and so we ask ourselves what it can mean when Hegel asserts that the subordinate changes – producing nothing really new - that nature is capable of rest on an oppositionlessness. Now it is wholly self-evident that in e v e r y change certain distinctions and therefore relative oppositions are involved. So Hegel must distinguish two types of oppositions. And in fact he does that, as is well known. Functionally he characterizes these types of oppositions by distinguishing partial and total negation.

But now to the first, classical negation with its partial and total variants Hegel adds yet his famous "second negation". For the purpose of clarifying the reciprocal relation of these two negations we want to introduce a new pair of concepts that we designate with the terms "contexturality" and "discontexturality". We will first illustrate what a contexture is with a few simple examples. If we speak of Being-in-General, then we mean by that a total systemic context that is closed in itself and is marked off from what Hegel calls pure Nothing. All the theoretical means that serve one within such a contextural context fail when one would go beyond the limits

menhangs bedient, versagen, wenn man vermittels ihrer über die Grenzen der Kontextur hinaus schreiten will. Das ist in der Anwendung auf die Diskontexturalität von Sein und Nichts völlig trivial. Jede logische Kette oder jeder arithmetische Zählprozeß, deren wir uns im Bereich des Seins bedienen, finden ein Ende, wenn wir versuchen, die Grenze vorn Sein zum Nichts zu überschreiten. Man kann im Nichts weder Schlüsse ziehen noch Dinge zählen.

Der Gegensatz von Sein und Nichts ist so der elementarste Fall von Diskontexturalität. Wäre er jedoch der einzige, dem unser Universum unterworfen wäre, so wäre die Hegelsche Logik überflüssig, und es wäre uns für immer unmöglich, über die klassische Tradition des Denkens und der Philosophie hinauszukommen. Tatsächlich aber ist unsere Wirklichkeit von weiteren Diskontexturalitäten durchwebt, die unendlich viele Kontexturen von einander trennen. So formt z. B. der Inbegriff aller bona fide Objekte eine Kontextur und der subjektive Bewußtseinsraum eines erlebenden Subjekts, das diese Objekte wahrnimmt, eine andere. Ein weiteres Beispiel der Diskontexturalität ist die radikale Trennung des Bewußtseinsraums eines Ichs von der sogenannten psychischen Sphäre eines Du. So sehr wir uns auch bemühen, wir können die Bewußtseinsvollzüge eines fremden Ichs nie als die unsern erleben, weil ja psychische Erlebnisse, die an verschiedene Ich-zentren gebunden sind, unterschiedlichen Kontexturen angehören und damit relativ zueinander diskontexturell sind.

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of that contexture by means of them. In application to the discontexturality of Being and Nothing that is quite trivial. Every logical sequence or every arithmetical counting process that serves us in the domain of Being comes to end when we attempt to overstep the boundary between Being and Nothing. In Nothing one can neither draw conclusions nor count things.

This is the most elementary case of discontexturality. If it were the only one that our universe is subject to, then the Hegelian topic would be superfluous, and it would be forever impossible for us to go beyond the classical tradition of thought and philosophy. But in fact our reality is woven through further discontexturalities that separate infinitely many contextures from one another. So, for example, the essence of all bona fide objects forms a contexture, and the subjective space of consciousness of an experiencing subject who perceives these objects forms another. A further example of discontexturality is the radical separation of an I from the co-called psychical sphere of a Thou. As much as we might try we could never experience the conscious acts of another I as our own, because psychical experiences that are bound to different I-centers belong to different contextures and so, relative to one another, are discontextural.

As it is well known, Hegel adds to the first classical negation in its partial and total version his famous ´second negation´. For the purpose of clarifying the mutual relation between these two negations we will introduce a new pair of concepts which will be called ´contexturality´ and ´discontecxturality´. First we will explain the meaning of ´contexture´ using some simple examples: If we speak from Being-in-General this means an totally systematic and closed context - a contexture – that differentiates itself from Nothingness as Hegel has called it. All theoretical tools defined within such a contexture fail if they are used in order to cross the border of the

schen Mittel, derer man sich innerhalb eines solchen kontexturellen Zusammenhangs bedient, versagen, wenn man vermittels ihrer über die Grenzen der Kontextur hinaus schreiten will. Das ist in der Anwendung auf die Diskontexturalität von Sein und Nichts völlig trivial. Jede logische Kette oder jeder arithmetische Zählprozeß, deren wir uns im Bereich des Seins bedienen, finden ein Ende, wenn wir versuchen, die Grenze vom Sein zum Nichts zu überschreiten. Man kann im Nichts weder Schlüsse ziehen noch Dinge zählen.

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Für die Idee einer Kontextur ist wesentlich, daß inhaltliche Gleichheit oder Unterschiede - also intra-kontexturale Identitäten und Differenzen - nicht das geringste für die Fusion oder Trennung zweier oder mehrerer Kontexturen beitragen. Wir wollen das an unserm letzten Beispiel der Kontexturalitätsdifferenz zweier Bewußtseinsräume, die sich als Ich- und Du-Sphären verhalten, etwas näher erläutern. Zuerst soll stipuliert werden, daß zwei Iche zu einer gegebenen Zeit "identische" psychische Erlebnisse haben, "dasselbe" fühlen, wollen oder auch die "gleichen" Gedanken entwickeln, - also des Poeten Wort verwirklichen: zwei Seelen und ein Ge-

contexture. This is trivial from the point of application of the discontexturality between Being and Nothingness. Every logical chain or any arithmetic process or counting performed within the range of the Being ends if we are trying to cross the border from the Being into the Nothingness. Within the Nothing it is impossible to draw conclusions or to count up things.

The opposition between Being and Nothingness is the most elementary case of discontexturality. If it would be the only one describing our universe then Hegel´s logic would be completely superfluous and it would be impossible for ever to go beyond the classical tradition of thinking and reflecting. Our reality, however, is interwoven by lots of further discontexturalities separating an infinite number of contextures. So the range of all bona fide objects represents one contexture and another one is represented by the psychical sphere of a conscious subject perceiving these objects. A further example of discontexturality is given by the radical separation between the sphere of consciousness of an I and the psychical sphere of a Thou. All our efforts to experience the conscious processes within another I will never be successful, because all psychical experiences bound to different I-centers belong to different contextures and are related dicontexturally to each other.

For the understanding of the concept of contexture it is important to know that with regard to contents equality or difference, i.e., intra-contextural identities and differences, do contribute anything for a fusion or a separation of two contextures. We will explain this point referring to our last example of two spheres of consciousness related as spheres of an I and a Thou. First, we stipulate that two I-centers experience at given time "identical" psychical events and that their feelings as well as their wills are "identical" and that they develop "identical" ideas – in other words, the realization of the poetry "zwei Seelen ein Gedanke"

danke, zwei Herzen und ein Schlag! Dann aber wollen wir umgekehrt stipulieren, daß zwei individuelle Ich-zentren nicht die geringsten Gedanken "gemeinsam" haben und daß sowohl die Gefühle des einen Ichs als auch seine Willensintentionen dem andern völlig fremd und unverständlich sind.

Soweit nun das Problem der Kontexturalitätsdifferenz zweier gesonderter Ich-zentren und der ihnen zugeordneten Bewußtseinsräume in Frage kommt, ist es völlig gleichgültig, welche der beiden oben beschriebenen Stipulationen wir akzeptieren. Sogenannte Gleichheit der Gefühle, Gedanken und Willensentscheidungen verringert die Kontexturalitätsschranke nicht im geringsten. Ebensowenig wie gegenseitiges totales Unverständnis und die Unmöglichkeit des Nachvollzugs fremder Bewußtseinserlebnisse sie erhöht. Die jeweiligen spezifischen Inhalte, die in einer Kontextur zusammengefaßt und strukturell verbunden sind, sind qua Inhalt völlig irrelevant. Was allein in Frage kommt, ist der strukturelle Abbruch, der zwischen zwei Kontexturalitäten existiert und der es unmöglich macht, daß ein gegebenes Ich je die Erfahrungen eines Du als die seinen erlebt. Für das Verhältnis zweier strukturgleicher Kontexturen ist die Relation von Urbild und Abbild proto-typisch.

Es läßt sich vielleicht noch hinzufügen, daß eine notwendige - aber nicht zureichende - Eigenschaft einer Kontextur darin besteht, daß in ihr das Tertium non datur derart gilt, daß die Alternative, die das Dritte ausschließt, von einer solchen erschöpfenden Allgemeinheit sein muß, daß sie keinem übergeordneten Bestimmungsgesichtspunkt (der Alternativen von größerer logischer Spannweite erlaubt) unterliegt. Reflexionsloses Sein- überhaupt kann für seine Inhaltsbestimmungen im Sinne eines radikalen Drittensatzes logisch nicht überboten werden. Also stellt es eine geschlossene Kontextur dar.

Wir behaupten nun, daß die klassische erste Negation Aristotelischer Provenienz als partielle Negation ausschließlich eine intra-kontexturelle Funktion hat. Sie negiert innerhalb einer Kontextur und sonst nirgends. Als totale aber negiert sie sich selbst und hebt damit die ganze Kontextur auf, in

[two souls one thought], or "zwei Herzen ein Schlag" [two hearts one heartbeat]. On the other hand, we stipulate that two I-centers do not share the slightest idea in common and their feelings and wills are completely different and totally strange and unintelligible.

Concerning the problem of contextural differences between the two different I-centers and their attributed spheres of consciousness it is completely unimportant which of the two stipulations we will accept. Neither the so called equality of feelings, thoughts and voluntary decisions reduces the barrier of contexturality nor is it enlarged by the total lack of understanding and reconstructing conscious experiences of the other I-center. The specific contents combined in a contexture are structurally related and their content is completely irrelevant. What counts is the structural rupture which exists between two contextures and which is responsible for the fact, that a given I never experiences the psychical events of a Thou as the experiences of it own. The relation between two structural equivalent contextures is determined by the relation between the original (prototype) and its image.

It may be added that a necessary – but not sufficient – attribute of a contexture is given by the range of the tertium non datur (the excluded middle) in a way that the alternative which excludes the third is of such an universal character that there is no overriding point of significance concerning the alternative. It is not possible to beat logically by means of the excluded third the reflectionless Being-in-General so far as its determination of the content is concerned. Therefore it represents a closed contexture.

Now we assert that the classical first negation, of Aristotelian provenance, has an intra-contextural function. It negates within a contexture and nowhere else. As total negation it negates itself and therefore nullifies completely the contexture in

der sich ihre partiellen Negationsfunktionen bewegen. Das ist Hegelsches "Aufheben" im Sinne von Vernichten. Im Gegensatz dazu hat das, was Hegel als "zweite Negation" bezeichnet, überhaupt keine intra-kontexturelle Funktion. Dieses Negieren hat transkontexturellen Charakter. In dieser neuen Operation wird die Gesamtheit einer Kontextur dadurch "verneint", daß man an ihre Stelle nicht das Nichts, sondern eine andere positive Kontextur setzt.

Innerhalb jeder gegebenen Kontextur herrscht nun jenes andere unveränderliche Strukturprinzip, von dem Hegel spricht. Der Übergang von einer Kontextur zu einer anderen von ihr positiv unterscheidbaren (die Kontextur des Nichts ist n i c h t von der Kontextur des reflexionslosen Seins unterscheidbar) aber bedeutet Wechsel eines Strukturprinzips. Es gehört zur Definition einer Kontextur, daß ihr struktureller Charakter durch intra-kontexturelle Operationen in keiner Weise verändert werden kann. Er kann aber auch nicht durch Hegels zweite Negation verändert werden, denn die letztere hat ja nur die Aufgabe, einen neuen und reicheren Strukturzusammenhang an die Stelle des alten zu setzen. Dieser schließt zwar - als Sub-Struktur - die vorangehende Kontextur ein (Hegels "Aufheben" als Bewahren), aber diese Sub-Struktur hat jetzt ihren universalen, alles-beherrschenden Kontexturcharakter verloren.

Dadurch, daß die zweite Negation nirgends Inhaltsbestimmungen, sondern nur die strukturellen Zusammenhänge gegebener Inhalte "verneint", verändert sie das bis dato geltende logische Prinzip. Der Gegensatz, von dem Hegel im Zusammenhang mit der Kategorie des Neuen spricht und den er mit der Gegensatzlosigkeit der sogenannten natürlichen Veränderung kontrastiert, ist der "totale" Gegensatz sich qua Kontextur ausschließender sub-kontexturelle Prinzipien und Zusammenhänge (s. Appendices). Verglichen mit ihm schrumpfen intra-kontexturelle, d.h. materiale, bzw. kontingente Differenzen bei gleichbleibendem Strukturprinzip zu relativer Gegensatzlosigkeit zusammen. Das Neue in der Geschichte, das nach Hegel aus der "unwillige(n) Arbeit" des Geistes an seinem Gegensatz entsteht, ist also nicht das Produkt sich bestreitender Inhaltsbestimmungen

which the partial negation functions. This is the meaning of Hegel´s "Aufheben" [sublation] in the sense of obliteration. In opposition to that, Hegel´s second negation has no intra-contextural function at all - it is trans-contextural. It negates the totality of a contexture and by this negation posits another contexture in its place instead of using the Nothing.

Within any given contexture there exists the unchangeable principle of structure which Hegel was speaking about. The transition between positively defined contextures, however, represents a change in the principle of structure (the contexture of the Nothing is n o t distinguishable from the contexture of the reflectionless Being). It belongs to the definition of a contexture that its structural character neither can be changed by any intra-contextural operations nor by Hegel´s so-called second negation. The idea of the second negation is to create a new and richer structural coherence instead of the old one that includes as a sub-structure the previous contexture which lost its dominating character as contexture.

Since the second negation rejects the structural connections of given contents instead of negating the contents, we are faced with a completely new logical principle. The opposition which Hegel discusses in connection with the category of the new and which he contrasts with the oppositionlessness of the natural changes is the t o t a l opposition of excluding sub-contextural principles and the coherences qua contexture (cf. appendices). Compared to this all intra-contextural, i.e., all material or rather contingent differences with invariable structure-principles shrink to a relative oppositionlessness. According to Hegel, the new in history results form the unwilling work ("unwillige Arbeit") of the spirit on its opposition and is not the product of challenging determinations of contents within one given contexture. It [the new in history] rather results from the

innerhalb einer gegebenen Kontextur. Es resultiert vielmehr aus dem Gegensatz zweier Kontexturen. Dieser Schluß ist unvermeidlich! Da das, was wir mythologisierend Geist nennen, reine Kontextur ist, kann der Geist sich selbst n u r als Kontextur zum Gegensatz haben, und nicht als vereinzelter kontextureller Inhalt.

opposition of two contextures. This conclusion is unavoidable! Since that what we call mythologically spirit has to be represented by a contexture, the spirit finds its opposition only in a contexture and not within an isolated contextural content.

Mit der einfachen Feststellung, daß die Hegelsche Kategorie des Neuen, die mit der Ablösung einer weltgeschichtlichen Epoche durch eine andere verbunden ist, identisch ist mit der Idee eines Kontexturwechsels in der Geschichte - deren historischer Motor die zweite Negation ist könnten wir uns begnügen und unsere Betrachtung abschließen, wenn Hegel nicht darauf hinwiese, daß die Weltgeschichte einen Stufengang der Entwicklung eines Prinzips darstellt derart, daß ein höheres Prinzip ein niedereres ablöst. Nun haben wir zwar die Idee eines Prinzips mit der strukturtheoretischen Konzeption einer geschlossenen Kontextur identifiziert. Was wir bisher aber über Kontexturen gesagt haben, gibt uns noch kein Recht zu behaupten, daß der Übergang von einer Kontextur zur nächsten ein Fortschreiten vom Niederen zum Höheren oder auch umgekehrt ein Regreß vom Höheren zum Niederen ist. Im Gegenteil: die Beispiele von Kontexturen, die wir bisher angeführt haben, z.B. die Diskontexturalität von reflexionslosem Sein und Nichts, oder von Ich- und Du-Subjektivität, schließen eine solche Möglichkeit ausdrücklich aus. Die Diskontexturalitätsrelation zwischen den bisher angeführten Kontexturen ist symmetrisch - also ein Umtauschverhältnis - und nicht hierarchisch. Um festzustellen, daß Hegel recht hat, wenn er vom Stufengang eines sich immer neu verwandelnden Prinzips in der Weltgeschichte spricht, müssen wir einen weiteren Begriff, nämlich den der asymmetrischen Diskontexturalität einführen.

With the simple result that the Hegelian category of the new, which is bound to the dissolution of one world historical epoch by another, is identical to the idea of a contextural change within history, we could be satisfied and conclude our observations, if it were not for the fact that Hegel indicates that world history represents a sequence of stages in the development of a principle to the extent that a higher principle absorbs a lower one. Now to be sure we have identified the idea of a principle with the structural-theoretic conception of a closed contexture. But what we have said about contextures so far still gives us no right to assert that the transition from one contexture to the next is a progress from lower to higher or a regress from higher to lower. On the contrary, the examples of contextures that we so far have cited, for example the discontexturality of I and Thou subjectivity, expressly exclude such a possibility. The discontextural relation between the previously cited contexture is symmetrical and not hierarchical, i.e, an exchange relation. In order to establish that Hegel is correct when he speaks of a sequence of stages of a principle that always changes anew, we must introduce another concept, namely that of asymmetrical discontexturality.

Was darunter zu verstehen ist, läßt sich am besten erläutern, wenn wir uns zuerst genau vergegenwärtigen, was unter symmetrischer Diskontexturalität zu verstehen ist. Zwecks Illustration wollen wir ein weiteres Beispiel elementarer Diskontexturalität anführen. Vielleicht der fundamentalste Ausdruck von elementarer Diskontexturalität neben dem die Hegelsche Logik eröffnenden

What is to be understood by that can best be explained if we recall precisely what is to be understood by symmetrical discontexturality. For purposes of illustration we want to cite a further example of elementary discontexturality. Next to the opposition of reflectionless Being and pure, undetermined Nothing with which Hegel

Gegensatz von reflexionslosem Sein und reinem bestimmungslosen Nichts ist die Zeit. Zeit ist, strukturtheoretisch betrachtet, nichts anderes als die Aktivierung einer Diskontexturalitätsrelation zwischen Vergangenheit und Zukunft. Wir können zwar Aussagen über die Vergangenheit machen, und wir können auch mit gewissen Reservationen Aussagen über die Zukunft machen, wir sind aber in keiner Weise fähig, theoretische Feststellungen über die Gegenwart zu machen, weil die Gegenwart im Prozeß der Aussage selbst sofort zur Vergangenheit wird. Alle überhaupt möglichen Aussagen müssen in eine Kontextur einzuordnen sein. Gegenwart aber bedeutet nichts anderes als Übergang von einer Kontextur zur anderen. Die Entdeckung, daß Vergangenheit und Zukunft diskontexturelle Zeitdimensionen sind, läßt sich bis auf Aristoteles zurückführen. Er weist nämlich im IX. Kapitel von PERI HERMENEIAS darauf hin, daß der Satz vom ausgeschlossenen Dritten sowohl für die Vergangenheit als auch für die Zukunft gültig ist, daß er aber nur auf die Vergangenheit anwendbar ist. Die beiderseitige Gültigkeit des Tertium non datur für die Vergangenheit sowohl wie für die Zukunft weist darauf hin, daß diese beiden Kontexturen, soweit das Gültigkeitsproblem in Frage kommt, ein symmetrisches Umtauschverhältnis bilden. Sie sind aufeinander abbildbar. Auf dem Boden der klassischen Logik ist der Zeitverlauf nur chronologisch und reflexionslos, d.h. er ist umkehrbar. Die Diskontexturalität der beiden Zeitdimensionen Vergangenheit und Zukunft kommt nun darin zum Ausdruck, daß bei beiderseitiger Gültigkeit des Drittensatzes derselbe immer nur auf einer Seite anwendbar ist. Die Seite, auf der wir ihn anwenden, ist diejenige, die wir dann Vergangenheit nennen.

Wir können die chronologische, undialektische, Zeit also als eine "temporale" Folge zweier Kontexturen betrachten, aber da diese Folge umkehrbar ist, liegt in ihr nichts, was auf einen Stufengang und einen Fortgang vom Niederen zum Höheren hinweist.

Andererseits aber verbinden wir mit dem Übergang vom Alten zum Neuen die Vorstellung der Nicht-Umkehrbarkeit. Das Neue ist nur deswegen neu,

opens his *Logic*, perhaps the most fundamental expression of elementary discontexturality is time. Structurally-theoretically considered, time is nothing but a discontextural relation between past and future. To be sure, we can make statements about the past, and with certain reservations we can make statements. about the future, but we are in no way capable of making theoretical assertions about the present, because in the process of making the statement itself the present becomes the past. All possible statements must be arrangeable within a contexture. But the present means nothing else but a transition from one contexture to another. The discovery that past and future are discontextural dimensions of time can be traced back to Aristotle. In the IXth chapter of PERI HERMENEIAS namely he indicates that the axiom of the excluded middle is valid for both the past and the future, but that it can be applied only to the past. The validity of the tertium non datur for both the past and the future shows that these two contextures form a symmetrical exchange relation. They can be seen as images of one another. On the grounds of classical logic the course of time is only chronological and reflectionless, i.e., it is reversible. The discontexturality of the two dimensions of time, past and future is expressed in that the reciprocal validity of the excluded middle is always applicable to one side only. The side to which we apply it is the very one that we call the past.

So we can consider chronological time as a "temporal" sequence of two contextures, but since this sequence is reversible there is nothing about it that indicates a sequence of stages and a progress from lower to higher.

On the other hand, however, we connect with the transition from old to new the conception of irreversibility. The new is only new because it comes after the old.

weil es nach dem Alten kommt. Was wir benötigen, ist also eine nicht-umkehrbare Diskontexturalitätsrelation. Wenn wir von Sein und Nichts sprechen, oder von Ich-Subjektivität und Du-Subjektivität, oder von Vergangenheit und Zukunft nur im chronologischen Sinne, dann sprechen wir von ungeordneten Paaren von Kontexturen. Um aus ihnen einen Stufengang zu machen, der den Hegelschen Begriff des gerichteten Werdens impliziert, müssen wir ein Schema finden, nach dem sich alle überhaupt möglichen Kontexturen ordnen lassen. Die Lösung dieses Problems ist bereits in der Hegelschen Logik vorhanden. Wie bekannt, beginnt die große Logik Hegels mit der undialektischen Entgegensetzung von Sein und Nichts, die dialektisch betrachtet aber eine Gleichsetzung ist. Sein-überhaupt designiert – worauf wir bereits hinwiesen - einen ungebrochenen ontologischen Zusammenhang. Sein- überhaupt hat nirgends Löcher. Genau das gleiche muß aber auch vom reinen Nichts behauptet werden. So wie das Sein keine Löcher hat, so wird das reine Nichts nirgends von Seinsbrocken unterbrochen. Hegel weist am Anfang der Großen Logik ausdrücklich darauf hin, daß beide Dimensionen strukturell völlig ununterscheidbar sind. Und doch sind sie diskontexturell, denn das Sein ist eben Sein und nicht Nichts. Der Sachverhalt ist in der mathematischen Logik längst bekannt, wo er als Isomorphie der Zweiwertigkeit und semantische Symmetrie von Affirmation und Negation erscheint. Diese Isomorphie stellt man auf die folgende Weise her:

a) Jede Aussage wird ihrer Negation zugeordnet.
b) Die Grundbeziehung 'Negation' wird sich selbst zugeordnet.
c) Der Grundbeziehung 'Konjunktion' wird die Grundbeziehung 'Disjunktion' zugeordnet.

Daraus erfolgt eine überraschende Tatsache: wenn wir uns. in unsern Aussagen über die Welt, der klassischen zweiwertigen Logik bedienen, dann sind wir in der Lage, zwei Aussagemengen zu bilden, die sprachlich äußerst verschieden sein können, die aber ontologisch genau dasselbe sagen. In seinem Vortrag auf einem Hegel-Kongress, der 1931 unter anderen Auspizien als heute abgehalten wurde,

So what we need is an irreversible discontextural relation. When we speak of Being and Nothing, or of I-subjectivity and Thou-subjectivity, or of past and future in the chronological sense, then we are speaking of unordered pairs of contextures. In order to make a sequence of stages out of them, which the Hegelian concept of directed Becoming implies, we must find a scheme according to which all possible conjectures can be ordered. The solution to this problem is already at hand in the *Logic* of Hegel. As is well known, the greater *Logic* of Hegel begins with the undialectical opposition of Being and Nothing, which dialectically considered however is an equivalence. Being-in- General designates - as we have already indicated - an unbroken ontological context. Nowhere does Being-in-General have breaks. But exactly the same thing must be asserted of Nothing. So just as Being has no breaks, so pure Nothing is nowhere broken by shards of Being. At the beginning of the greater *Logic* Hegel expressly indicates that both dimensions are wholly indistinguishable structurally. And yet they are discontextural, for Being is indeed Being and not Nothing. This state of affairs has long been known in mathematical logic, where it appears as the isomorphism of two-valuedness and the semantic symmetry of affirmation and negation. This isomorphism is posed as follows:

a) every statement is ordered with its negation
b) the basic relation ´negation´ is itself ordered
c) the basic relation ´conjunction´ is ordered with the basic relation ´disjunction´.

A surprising fact results from that: when we make use of the classical two-valued logic in our statements about the world, then we are in a position to form two sets of statements that linguistically are extremely different but that say exactly the same thing ontolologically. In his lecture to the second Hegel Congress, held at Hum-

wies der Mathematiker Reinhold Baer auf diese Isomorphie mit der Bemerkung hin: "Jede Aussage ist zwar von ihrer Negation verschieden, aber es besteht kein wesentlicher Unterschied zwischen positiven und negativen Aussagen, sogar schärfer zwischen einer Aussage und ihrer Negation." Obgleich Reinhold Baers Behauptung unantastbar ist, besteht unser logischer Instinkt darauf, daß zwischen einer Aussage und ihrer Negation doch ein wesentlicher ontologischer Unterschied besteht. Und dieser Instinkt hat recht. Wenn wir nämlich den Inbegriff aller affirmativen Aussagen, die aus der klassischen Logik hervorgehen, auf Hegels reflexionsloses Sein abbilden und den isomorphen Inbegriff aller Negationen dieser Aussagen auf das ebenso reflexionslose Nichts, dann demonstriert unsere Isomorphie die totale Diskontexturalität von Sein und Nichts. Hegel hat für diese Diskontexturalität einen wohlbekannten Terminus: Unmittelbarkeit. Aber Unmittelbarkeit allein ist noch keine Gewähr für Neues.

Wir wollen jetzt den Begriff der Isomorphie zweier Kontexturen, die trotz ihres isomorphischen Charakters diskontexturell getrennt sind, im Lichte der Hegelschen Kategorie des Neuen betrachten. Zwar ist jeder vorstellbare zähl-, denk- und objektivationsfähige Wirklichkeitsprozeß in eine gegebene strukturelle Kontextur eingeschlossen. Ist aber eine zweite Kontextur der ersten in dem von Baer beschriebenen Sinn also zweiwertig und undialektisch isomorph, dann lassen sich diese Prozesse in der zweiten Kontextur spiegelbildlich wiederholen. Das bedeutet nun, daß alle angeblichen Aussagen über das Nichts, in denen man sich negativer Aussageformen bedient - wie das z. B. die negative Theologie des Dionysius Areopagita tut -, in Wirklichkeit nichts anderes sind als maskierte Aussagen über das affirmative reflexionslose Sein! Und wenn Sein und Nichts nur einfache Spiegelungen voneinander sind, dann können wir im Abbild nichts lesen, was wir nicht schon im Urbild erfahren haben. Daraus folgt - um zu unserer thematischen Kategorie des Neuen zurückzukehren -, daß nach allem, was wir aus dem Sein gelernt haben, uns das Nichts keine Neuigkeit mehr bieten kann.

boldt University in 1931, the mathematician Reinhold Baer referred to this isomorphism with the remark: "To be sure, every statement is distinct from its negation, but there is essentially no difference between positive and negative statements, even less so between a statement and its negation." Although Reinhold Baer's assertion is incontestable, our logical instinct insists that an essential ontological distinction does exist between a statement and its negation. And this instinct is correct. If in fact we place the essence of all affirmative statements that arise from the classical logic on the side of Hegel´s reflectionless Being, and the isomorphic essence of all the negations of these statements on the side of the equally reflectionless Nothing, then our isomorphism demonstrates the total discontexturality of Being and Nothing. Hegel has a well known term for this discontexturality: Immediacy. However, immediacy alone does not guarantee the appearance of the new.

We want now in the light of the Hegelian category of the new to consider the concept of the isomorphism of two contextures that despite their isomorphic character are separated discontexturally. To be sure, every conceivable counting, thought, and objectification-capable process of reality is included in a given structural contexture. But if a second contexture is isomorphic to the first in the sense described by Baer, then these processes can be repeated, mirror-like, in the second contexture. But that means that all alleged statements about Nothing, in which one makes use of statements - as for example in the negative theology of Dionysias Areopagita - are in reality nothing but masked statements about affirmative reflectionless Being. And if Being and Nothing are but simple mirror images of one another, then in the one we can find nothing that is not also to be found in the other. It follows - to return to our thematic category of the new - that after all we have learned from Being Nothing cannot offer us anything new.

Damit wird deutlich, daß die Hegelsche Kategorie des Neuen mit dem strukturellen Prinzip der Anisomorphie verbunden sein muß. Wenn Hegel behauptet, daß es in der Natur nichts Neues gäbe, dann meint er damit, daß die Kategorie des Neuen, so wie er sie versteht, in Symmetriesystemen keine Anwendung finden kann. Damit ist das Mythologem ´Natur´ im Sinne der Hegelschen Philosophie völlig säkularisiert. "Natur" bedeutet Symmetrie von Seinssystemen. D.h. das, was in einem gegebenen Objektivzusammenhang symmetrisch ist, das ist "natürlich". Unsere weiteren Ausführungen antizipierend, können wir sagen, daß ein erster Schritt zur Säkularisation des Terminus 'Geist' damit getan ist, daß wir von dem letzteren sagen, er sei eine Manifestation eines asymmetrischen Verhältnisses von Kontexturen.

Soweit unsere klassische Tradition des Denkens auf einer zweiwertigen, undialektischen Logik ruht, ist sie, wie bekannt, die Lehre aller Symmetriestrukturen der Welt. Eine symmetrische Welt aber ist eine total unhistorische Welt, in der in dem von Hegel definierten Sinn echtes Neues nicht auftreten kann. Umgekehrt ist Geschichte nur ein umgangssprachlicher Ausdruck für strukturelle Asymmetrie der Wirklichkeit.

Tatsächlich aber liegt in der Relation zwischen reflexionslosem Sein und reinem Nichts mehr, als Reinhold Baer darin gesehen hat. Diese Relation enthält - vom Standpunkt des Dialektikers her - eine Asymmetrie, der wir jetzt nachgehen wollen. Wir finden sie in der Hegelschen Unterscheidung von Unmittelbarkeit und Vermittlung. Sein und Nichts stehen sich einerseits als Unmittelbarkeiten gegenüber, und insofern entspricht ihre gegenseitige Beziehung der Baerschen Beschreibung. Sie sind aber auch, wie Hegel am Anfang der Großen Logik bemerkt, in der Kategorie des Werdens miteinander vermittelt. Aber Termini wie Vermittlung und Werden sind im Grunde genommen auch nur durch die Umgangssprache erzeugte Mythologeme, solange man nicht in der Lage ist, sie auf strukturelle Eigenschaften der Wirklichkeit zurückzuführen.

At that it becomes clear that the Hegelian category of the new must be bound to the structural principle of anisomorphism. When Hegel asserts that there is nothing new in nature, then he means by that that the category of the new, as he understands it, can find no application in systems of symmetry. At that the mythologem "nature" in the Hegelian philosophy is fully secularized. "Nature" means symmetry of ontological systems, i.e., that what is symmetrical within a given objective connection is "natural". In anticipation of our further expositions we can say that a first step towards secularization of the term "spirit" has been taken that we can say of the latter that it is a manifestation of an asymmetrical relation of contextures.

In so far as our classical tradition of thought rests on a two-valued, undialectical logic, it is the doctrine of all symmetry structures in the world. But a symmetrical world is a totally ahistorical world in which nothing genuinely new can appear in the sense defined by Hegel. Inversely, "history" is but the common language expression for the asymmetry of reality.

But in fact there is more to the relation between reflectionless Being and pure Nothing than Reinhold Baer has seen. This relation contains - from the standpoint of the dialectician - an asymmetry that we now want to investigate. We find it in the Hegelian distinction between Mediacy and Immediacy. On the one hand Being and Nothing confront one another as Immediacies, and to that extent their mutual relationship corresponds to Baer´s description. But they are also, as Hegel remarks at the beginning of the greater *Logic* mediated in the category of Becoming. But terms like "mediation" and "becoming" are fundamentally too only mythologems, produced by the common language, so long as one is not in a position to refer them back to structural properties of reality.

Um dieser Aufgabe zu genügen, weisen wir darauf hin, daß der Hegelsche Terminus 'Vermittlung' nur dann einen exakten Sinn haben kann, wenn der Terminus 'Sein' (oder invers auch der des ´Nichts´) zwei verschiedenen Relationen angehört. Das ist in der Tat der Fall. Einerseits steht Sein in einem symmetrischen Umtauschverhältnis mit Nichts, und darüber haben wir bereits genügend gesprochen. Sein steht aber auch und dies ist die subtilere Beziehung - in einer Relation zu dem symmetrischen Umtauschverhältnis, das zwischen ihm selbst und dem Nichts statthat! Um diesen Sachverhalt auf die einfachste Formulierung zu bringen, können wir sagen: Für die klassische, auf der zweiwertigen Logik fußenden, undialektischen Relationstheorie ist eine Relation nichts weiter als das Verhältnis zwischen zwei Relationsgliedern. Eine dialektische Theorie der Relation muß aber zusätzlich feststellen, daß jedes Verhältnisglied, abgesehen von seiner Beziehung zum anderen, auch noch eine Relation zu dem Umtauschverhältnis selbst hat, das zwischen ihm selbst und dem andern Relationsglied besteht. Es ist klar, daß diese Relation zwischen Verhältnisglied und dem Verhältnis selbst sich von dem symmetrischen Verhältnis zwischen den beiden Relationsgliedern insofern unterscheiden muß, als in ihm die Relationsglieder nicht mehr vertauschbar sind.

Solange sich Sein und Nichts als Unmittelbarkeiten gegenüber standen, waren sie beliebig vertauschbar, also umkehrbar eindeutig aufeinander abbildbar; und durch ihre Vertauschung konnte an ihrer gegenseitigen Beziehung nicht das geringste geändert werden. Sein und Nichts stellten deshalb kein geordnetes Paar dar. Formen wir jetzt aber ein neues eigenartiges Verhältnis, wo auf der einen Seite das Sein (oder auch das Nichts) steht und auf der andern Seite jedoch die Umtauschrelation von Sein und Nichts, dann stellen in diesem Verhältnis die beiden Relationsglieder ein geordnetes Paar dar. Da sie nicht mehr aufeinander abbildbar sind, besitzt die Relation einen Richtungssinn. Das ist, was der Hegelsche Terminus 'Werden' bedeutet, ein Werden, in dem das Sein und das Nichts am Anfang der Großen Logik vermittelt sind.

In order to satisfy this task we make reference to the fact that the Hegelian term "mediation" can have an exact sense only then when the term "being" (or, inversely, "nothing") belongs to two different relations. That is in fact the case. On the one hand Being stands in a symmetrical exchange relation with Nothing, and we have said enough about that already. But Being also stands - and this is the more subtle connection - in a relation to the symmetrical exchange relation that occurs between it and Nothing. In order to bring this state of affairs into the most simple formulation we can say: for the classical, undialectical relation theory resting on two-valued logic a relation is nothing more than the relation between the two members of the relationship. But a dialectical theory of relations must additionally establish that every member of a relationship, its connection to the other member aside has yet another relation to the exchange relation itself that exists between it and the other member of the relation. It is clear that this relation between relational member and relation must be distinguished at once from the relation between the two relational members, as in the former the relational members are no longer exchangeable.

As long as Being and Nothing confronted one another as Immediacies they were exchangeable at will; and by their exchange nothing in the least could be changed concerning their reciprocal relation. So Being and Nothing represent no ordered pair. But if we now form a new and unique relation where on Being (or Nothing) stands on the one side and the exchange relation of Being and Nothing stands on the other, then in this latter relation the two relational members do represent an ordered pair. Since they no longer can be mapped onto one another the relation possesses a sense of direction. That is what is meant by the Hegelian term "becoming", a Becoming in which Being and Nothing are mediated at the beginning of the *Greater Logic*.

Wir wollen jetzt diese Überlegungen in die Sprache unserer Kontexturalitätstheorie übersetzen. Wir bemerkten, daß das Sein eine Kontextur ist und das Nichts eine andere. Wir führten weiterhin - auf dem Weg über Hegels zweite Negation - auch bereits den Begriff der Dis- und Transkontexturalität ein. In dieser manifestiert und reflektiert sich die Relation zwischen den beiden Kontexturen. Damit sind wir in der Lage, im Rahmen der Kontexturalitätstheorie zwei fundamentale Relationen zu definieren: erstens die Umtauschrelation zwischen zwei sich gegenseitig ausschließenden Elementarkontexturen; und zweitens die Relation zwischen Kontextur und Transkontexturalität, die uns infolge ihrer Asymmetrie die Möglichkeit gibt, logisch rechts und links und damit ontologisch auch vorher und nachher zu unterscheiden.

Da wir Transkontexturalität nur dort feststellen können, wo wir eine Beziehung zwischen mindestens zwei Kontexturen haben, läuft das Problem der zweiten asymmetrischen Relation auf die einfache Frage hinaus: Wie verhält sich eine Einzelkontextur zu Strukturen von höherer Komplexität, die aus mindestens zwei oder auch mehr Kontexturen konstruiert werden können?

Nun läßt sich zeigen, daß Systeme mit graduell wachsender Anzahl von Elementarkontexturen einen eigenartigen Aufbau formen, auf den der Hegelsche Terminus 'Stufengang´ vorzüglich paßt. Es ist ebenfalls demonstrierbar, daß in transkontexturellen Zusammenhängen höherer Ordnung - infolge der größeren Komplexität des Gesamtsystems - logische Eigenschaften auftreten, die in den isolierten Elementarkontexturen schlechterdings nicht aufweisbar sind. Insofern existieren in den stufenartig sich erweiternden transkontexturellen Synthesen die ontologischen Bedingungen für das Auftreten von Neuem.

Der Übergang von einer Kontexturalitätsstufe zur nächsten wird durch Hegels zweite Negation besorgt. Es ist charakteristisch für die klassische erste Negation, daß durch ihre Anwendung nie und nirgends eine Anreicherung an kontextureller Struktur erfolgt. Umgekehrt ist charakteristisch für Hegels zweite Negation, daß jede erneute Anwendung die Komplexität des Gesamtsystems erhöht. Das bedeutet aber auch,

We now want to translate these considerations into the language of our theory of contexturalities. We observed that Being is one contexture and that Nothing is another. Further we introduced the concept of transcontexturality. At that we are in a position to define two fundamental relations in the frame of the theory of contexturalities: first the exchange relation between two mutually exclusive elementary contextures, and, second, the relation between contexture and transcontexturality, which in consequence of its asymmetry gives us the possibility of distinguishing "left" from "right" logically and therefore "before" end "after" ontologically

Since we can only establish transcontexturality there where we have a relation between at least two contextures, the problem of the second, asymmetrical relation reduces to the simple question: what is the relationship of a single contexture to structures of higher complexity that can be constructed out of at least two or more contextures?

Now it can be shown that systems with a gradually increasing number of elementary contextures form a unique structure that is a good match for the Hegelian term "sequence of stages". At the same time it can be demonstrated that in transcontextural contexts of higher order - in consequence of the greater complexity of the whole system - logical properties appear that are not at all in evidence in the isolated elementary contextures. To that extent the ontological conditions for the appearance of the new exist in the staged self-expanding transcontextural syntheses.

The transition from one contextural stage to another is provided by Hegel´s second negation. For the classical first negation it is characteristic that an enrichment of contextural structure never results from its application. Inversely, it is characteristic of Hegel's second negation that every new application raises the complexity of the whole system. But that also means that this

daß diese Negation eine neue funktionelle Definition erfordert. Hegels berühmter Terminus 'zweite Negation' ist also im Grunde genommen ein Sammelbegriff für eine Hierachie von transklassischen Negationen von sich dauernd vergrößernder Reichweite. An dieser Stelle mündet eine Untersuchung der Hegelschen Logik in die philosophische Theorie transklassischer sogenannter mehrwertiger Logiken ein, die letzten Endes nichts anderes sind als progressive Formalisierungsstadien der Dialektik. Klassische Affirmation und Negation produzieren allein weder formal noch nicht-formal ein dialektisches Verhältnis. Sie sind, um ein einfaches Bild zu gebrauchen, in den Kontexturen gefangen. Die Trennungswand zwischen den Kontexturen vereitelt ein dialektisches Zusammen - oder auch Gegenspiel.

Um diese Betrachtung abzuschließen, wollen wir noch einmal zu der Kategorie des Neuen in der Hegelschen Geschichtsphilosophie zurückkehren. Wir erinnern uns, daß Hegel in den von uns angeführten Zitaten die Kategorie des Neuen mit dem Auftreten einer frischen historischen Epoche assoziierte ... einer Epoche, die ein bisher nicht dagewesenes generelles Prinzip zum Ausdruck bringt. Auf der andern Seite ist es selbstverständlich, daß eine neue Epoche auch neue Inhalte hervorbringt. Der Gegensatz zweier historischer Epochen beruht also auf einer doppelten Negation: erstens einer gegenseitigen Negation von Inhaltlichkeit das ist das Aristotelische Moment des Negativen - und einer gegenseitigen Negation von Kontexturprinzipien. Das ist Hegels zweite Negation.

Eine dialektische Struktur entsteht, wenn zu bloßen Inhaltsrelationen die spezifischen Strukturbedingungen einer Kontextur hinzukommen, die andere Kontexturverhältnisse ausschließt. Da sich aber gegenseitig widersprechende Kontexturen transkontexturell zusammenschließen lassen, entstehen Strukturbedingungen, die sich nicht mehr undialektisch behandeln lassen.

Da andererseits kein Zweifel daran bestehen kann, daß der Kontexturbegriff exakt definierbar ist und daß gleiches auch von dem Prinzip des Transkontexturellen gesagt werden kann, so ergibt

negation requires a new functional definition. So Hegel´s famous term "second negation" is fundamentally a collective concept for a hierarchy of transclassical negations of continuously increasing scope. At this point an investigation of the Hegelian logic merges with the philosophical theory of transclassical, multi-valued logics, which in the end are nothing but successive stages in the formalization of dialectics. Classical affirmation and negation alone produce neither formally nor informally a dialectical relation. They are, to use a simple image, caught in the cages of their separate contextures. The line of demarcation between the contextures obstructs any dialectical interplay - or even opposition.

To conclude these observations we want to return once more to the category of the new in the Hegelian philosophy of history. We recall that in the quotations cited by us Hegel associates the category of the new with the appearance of a fresh historical epoch ... an epoch that expresses a general principle previously not present. On the other hand it is self-evident that a new epoch brings with new contents also. So the opposition between two historical epochs rests on a double negation: first, a reciprocal negation of contents - that is the Aristotelian negative moment-, and, second, a reciprocal negation of contextural principles. That is Hegel´s second negation.

A dialectical structure arises when to mere content relations the specific structural conditions of a contexture are added that exclude other contextural relations. But since reciprocally opposing contextures can be assembled transcontexturally, structural conditions arise that can no longer be handled undialectically.

Since on the other hand there can be no doubt that the contexture concept can be defined exactly, and that the same can be said of the principle of transcontexurality, so it turns out that even the theory of

sich, daß auch die Theorie der Dialektik progressiv einem Formalierungsprozeß zugänglich sein muß. Wir sagen ´progressiv', denn die Totalität des dialektischen Prozeßes, die von absoluter Allgemeinheit bis zur letzten vereinzelten Individualität reicht, wird in toto unformalisierbar bleiben. Mathematisch gesprochen: Die Formalisierungsbedingungen der Dialektik müssen rekursiv sein.

Diese Rekursivität der dialektischen Strukturen ist unaufhebbar, weil sie auf einer grundsätzlichen ontologischen Voraussetzung für das Verhältnis von Reflexion und Zeit beruht - einer Voraussetzung, die auch in das Hegelsche Geschichtsbild eingegangen ist. Es ist oft bemerkt worden, daß die Griechen, die die Grundlagen unseres klassischen Weltbilds entwickelten, sich bemühten, ein zeitloses theoretisches Bild des Kosmos zu entwerfen. Dieser Kosmos unterlag dem Gesetze der ewigen Wiederholung des Gleichen, weil ihm die historische Dimension des Einmaligen und nicht Wiederholbaren fehlte. Für diese klassische Auffassung ist die Wirklichkeit eine einzige geschlossene Kontextur, in der es bestenfalls Diskontinuierliches von faktisch-inhaltlichem Charakter gibt. Alle Abbrüche von kontexturellen Zusammenhängen sind in diesem Weltbild nur scheinbar und vorläufig. Sie beruhen, wie Kant später sagt, auf einer transzendentalen Illusion. Für das klassische Denken finden sich alle Gegensätze, so wild und unversöhnlich sie sich auch in dieser Welt gebärden, letzten Endes zusammen in der göttlichen Coincidentia Oppositorum des Nicolaus Cusanus. In andern Worten: Das griechisch-christliche Weltbild ist mono-kontextural. Das Hegelsche ist polykontextural. Es ist höchst bezeichnend, daß die Coincidentia Oppositorum bei Hegel nirgends systematisch verwertet wird; es sei denn, wir betrachten die dialektische Einheit von Sein und Nichts als Coincidentia Oppositorum. Aber diese Pseudo-Einheit ist bei Hegel nicht das Ende der Heilsgeschichte der Welt, sondern ein ganz säkularer elementarer Anfang. Deshalb gewinnen wir aus der Hegelschen Geschichtsphilosophie ein bisher nicht dagewesenes philosophisches Bild des Wirklichen. Vom Standpunkt der Hegelschen Dialektik aus gesehen ist die Welt nicht eine geschlossene Kontextur, die alles Inhaltli-

dialectics is accessible to a process of progressive formalization. We say "progressive", for the totality of dialectical processes, which reaches from absolute generality on down to the last isolated particularity, will remain in toto unformulizable. Said mathematically: the formalization conditions for dialectics must be recursive.

This recursion of the dialectical structures cannot be transcended, because they rest on a fundamental ontological presupposition concerning the relation of reflection and time - a presupposition that even enters into the Hegelian image of history. It has often been remarked that the Greeks, who developed the foundation of our classical image of the world, attempted to sketch a theoretical image of the cosmos that was timeless. This cosmos was subject to the law of the eternal return of the Same, because it lacked the historical dimensions of the singular and the non-repeatable. For this classical conception reality is one single closed contexture in which at best there are discontinuities of a factual-content character. All breaks of contextural contexts are in this world image only apparent and temporary. They rest, as Kant later said, on a transcendental illusion. For the classical logic all oppositions, however wild and irreconciliable they may behave in this world, come together in the end in the divine Coincidentia Oppositorum of Nicholas of Cusa. In other words: The Greek-Christian conception of the world is mono-contextural while the Hegelian view of the world is poly-contextural. It is most characteristic that Hegel never mentions or systematically exploits the coincidentia oppositorum, unless then we consider the dialectical unity of Being and Nothing as coincidentia oppositorum. But this unity is for Hegel not the end of the sacred history of the world but rather a wholly secular elementary beginning. So we gain from the Hegelian philosophy of history an ontological image of the real previously not present. Seen from the standpoint of the

che umfaßt und es auf einen metaphysischen Generalnenner bringt. Sie ist vielmehr ein System von sich unendlich erweiternden Kontexturen von beständig wachsendem strukturellem Reichtum. In ihr verwirklicht sich eine unvollendbare, ins Unendliche ausgespannte Poly-Kontexturalität. In dem alten klassischen Weltbild, das zwar inhaltlichen Reichtum, aber totale kontexturelle Einfachheit besaß, konnte es nichts echt und wirklich Neues geben. Weshalb die nach Neuem suchende Sehnsucht des Menschen ein überirdisches Paradies oder seine das Neue fürchtende Angst eine unterirdische Hölle jenseits der Grenzen des Lebens setzte. Paradies und Hölle waren der einzige Kontrast zur ewigen Wiederkehr des Alten im Dasein. Die Idee eines himmlischen oder höllischen Jenseits ist in der Tat ein Ausdruck für Diskontexturalität aber eben nur ein mythologischer Ausdruck. Und die Weltgeschichte als Heilsgeschichte betrachtet, wie das die klassische Tradition tut, ist nichts weiter als Vorbereitung auf jenes Neue, das jenseits dieses irdischen Lebens west. Aber wenn die Heilsgeschichte nur auf das Neue v o r b e r e i t e t, dann kann in ihr selbst nichts Neues auftreten; denn damit verlöre sie ja ihren Charakter als Vorbereitung.

Der grundsätzliche Unterschied der Hegelschen Geschichtsauffassung gegenüber der klassischen Tradition besteht nun darin, daß er die Diskontexturalität, die in der platonischen Ideenlehre, und anderswo, das Diesseits vom Jenseits trennt, säkularisiert und in die Geschichte selbst hineinnimmt. Das Vehikel dazu ist für ihn die Kategorie des Neuen. Die Geschichte ist für ihn das Medium, in dem total Neues entsteht. Total Neues aber kann i n n e r h a l b einer gegebenen Kontextur nicht auftreten. Und da Hegel - richtig oder falsch - die Natur als geschlossene Kontextur interpretiert, kann sie nach seiner Auffassung intra-kontexturell nichts echtes Neues hervorbringen. Der triviale Übergang von einem Inhalt zum nächsten produziert höchstens solche subalterne "Neuheit", wie wir sie in wechselnden Kleidermoden finden. Aber daran ist die Philosophie nicht interessiert. Das echte Neue, das dem philosophischen Blick standhalten kann, erfordert inhaltliche Veränderung sowohl als Wechsel der Kontextur. Damit ist aber

Hegelian philosophy the world is not a closed contexture that embraces all contents and reduces all to a common denominator. Rather it is a system of infinitely self-expanding contextures of constantly increasing richness. Within this system an unfinishable poly-contexturality realizes itself that is extended at infinity. In the old classical image of the world, which to be sure possessed not a richness of contents but a total simplicity of contexture, there could be nothing genuinely and really new. Hence the yearning of men for a celestial paradise, or their fear of a hell, beyond the limits of life. Paradise and Hell were the sole contrast to the eternal return of the old in earthly existence. The idea of a heavenly or hellish *Jenseits* [the beyond] is in fact an expression for discontexture - but all the same only a mythological expression. And world history viewed as sacred history, as the classical tradition does, is nothing more than a preparation for that new that lies beyond this earthly life. But if sacred history only p r e p a r e s for the new, then nothing new can appear within it, for then it would lose its character of preparation.

The fundamental difference between the Hegelian conception of history and that of the classical tradition is that he secularizes the discontexture that in the Platonic doctrine of the ideas - and elsewhere – severs *Diesseits* from *Jenseits*, and brings this discontexture into history itself. The vehicle for that is for him the category of the new. History is for him the medium in which the totally new arises. But the totally new cannot appear w i t h i n a given contexture. And since Hegel - rightly or wrongly - interprets nature as a closed contexture, according to his conception it cannot bring forth anything genuinely new intra-contexturally. The trivial transition from one content to another produces at most such inferior "novelties" as the changing fashions in clothing. But philosophy is not interested in that. The genuinely new that can withstand the glance of philosophy demands a change not only in content but also of con-

nicht nur die erste sondern auch die zweite Negation involviert. Mit andern Worten: Die historische Kategorie des Neuen in Hegels Geschichtsphilosophie ist das Resultat eines real-dialektischen Prozesses.

Es kann somit keine historische Epoche geben, an deren Zukunftshorizont nicht schon ein Neues wartet. Nur die undialektische Betrachtung der Geschichte will ihr ein unüberholbares Ziel oder ein Jüngstes Gericht setzen. Die Dialektik des Neuen aber garantiert uns - kraft ihrer rekursiven Natur - die ewige schöpferische Offenheit des geschichtlichen Prozesses.

texture. But for that not only the first but also the second negation is involved. With other words: the historical category of the new in Hegels philosophy of history is the result of a dialectical process.

Therefore no historical epoch exists without a waiting new at its horizon of future. Only the undialectical consideration of the history wants to put a non-overtakable goal or a Last Judgment. Caused by its recursive nature, the dialectic of the new guarantees the endless creative openness of the historical process.

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APPENDIX 1

Wenn im Text bemerkt worden ist, daß die Idee des Diskontexturellen eine "zweite Negation" und eine transklassische Logik impliziert, so ist damit das Prinzip der Mehrwertigkeit ins Spiel gebracht, denn die Hegelsche zweite Negation konstituiert ja einen dritten Wert.

Mehrwertigkeit aber ist vorläufig ein Begriff, der meistens Verwirrung stiftet, weil die überwiegende Anzahl der Logiker immer noch nicht intrakontexturelle und trans-kontexturelle Mehrwertigkeit unterscheiden. D.h., wir können erstens mit einer gewissen Berechtigung von Mehrwertigkeit sprechen, wenn wir von logischen Themen handeln, die sich auf die inhaltlichen Details einer gegebenen und in sich geschlossenen Kontextur beziehen. Wir können zweitens aber auch in einem ganz andern Sinne von Mehrwertigkeit reden, wenn der Übergang von einer Kontextur zur anderen in Frage steht. Der erste Typ von Mehrwertigkeit ist zum mindesten seit 1920 bekannt, d.h. seit den frühen Arbeiten von Lukasiewicz und Post zu diesem Thema. Wir wollen diesen Begriff kurz erläutern.

Es ist möglich zwischen Negation und Position Zwischwerte einzuführen, die dann meist als Wahrscheinlichkeitswerte oder Modalitätswerte interpretiert werden. Um die Position dieser zusätzlichen Werte zu bezeichnen, braucht Lukasiewicz ausdrücklich das Wort 'zwischen'. Und Post spricht von 'gemischten' (mixen) Werten, die weder voll negativ noch voll affirmativ sind, sondern einen Kompromiß zwischen diesen beiden logischen Wertextremen darstellen. Gebraucht man nach dem Vorbild der Boolelschen Algebra für Negation das Zeichen 0 und für Affirmation das Zeichen 1, dann ergibt sich für die Lokation der zusätzlichen Werte das folgende Schema:

0 . . . . . ¼ . . . . . ½ . . . . . ¾ 1

Man kann dann sinnvoll von einer drei-

In the foregoing essay it was mentioned that the idea of dicontexturality implies a "second negation" and a transclassical logic. This marks the principle of many-valuedness because Hegel´s second negation constitutes a third value.

Many-valuedness, however, is a concept which still causes a lot of confusion since most logicians do not distinguish between intra-contextural and trans-contextural [or inter-contextural] many-valuedness. In other words, we can speak with a certain justification about many-valuedness if we are discussing logical themes with regard to contents of certain details w i t h i n a closed contexture. On the other hand we also can speak about many-valuedness in completely different sense, namely if the transition between different contextures is concerned. The first type of many-valuedness is very well known at least since 1920 from the very early studies of Lukasiewicz and Post concerning this field of logic. We will explain the (first) conception of many-valuedness very shortly.

It is possible to introduce intermediate values between negation and position (affirmation) which are interpreted mostly as probability values or as values of modality. In order to characterize these values Lukasiewicz explicitly uses the term ´intermediate´. And Post speaks about ´mixed´ values which are neither completely positive nor completely negative and which have to be considered as a kind of compromise bewtween these the two logical extreme values. According to the Boolian algebra one uses 0 for the negation an 1 for the affirmation. For the location of the additional (intermediate) values it follows:

0 . . . . . ¼ . . . . . ½ . . . . . ¾ 1

wertigen Logik sprechen oder auch von einer solchen, die eine unendliche Anzahl von Zwischenwerten zwischen Negation und Affirmation einführt.

Es ist berechtigt, von Mehrwertigkeit in diesem Sinne zu sprechen, solange man sich gegenwärtig hält, daß die derart eingeführten Werte nicht strikt formal sind, sondern kontingente Inhaltlichkeit implizieren, wie von Oskar Becker betont worden ist.

Es ist selbstverständlich, daß diese Mehrwertigkeit nur von geringem Nutzen in der Interpretation der Hegelschen Logik ist, da die letztere eine Theorie reiner Strukturen darstellt. Es gibt aber auch noch einen zweiten Begriff der Mehrwertigkeit, wie er vom Verfasser dieser Zeilen in den 50er Jahren in die Logik eingeführt worden ist. In diesem zweiten Fall sind die zusätzlichen Werte nicht innerhalb der Antithese von Negation und Affirmation lokalisiert, sondern sie befinden sich 'außerhalb' und dienen dem Zweck, neben der zweiwertig klassischen Logik, die völlig intakt gelassen wird, neue logische Systeme zu formieren.

Wir wollen, was wir meinen, an dem einfachen Beispiel der klassischen Konjunktion illustrieren. Wir werden aber für unsere Demonstration nicht den Boole´schen Symbolismus benutzen, sondern wir setzen, wie das in vielen Schriften über Mehrwertigkeit heute üblich ist, für Affirmation die natürliche Zahl 1 und führen für die Negationen dann die darauf folgenden natürlichen Zahlen (2, 3, 4, ...) ein. Und da im Bereich dieser Arbeit nur von relativ elementaren Fällen der zweiten Hegelschen Negation die Rede war, wollen wir uns für die Wertcharakterisierung mit den Zahlen 1, 2 und 3 begnügen. Außerdem benötigen wir noch ein Minimum von zwei Variablen p und q und ein Zeichen für Konjunktion: &. Die Tafel für die klassische zweiwertige Konjunktion hat dann die folgende Gestalt:

In that case one can speak about a three-valued logic or of a logic with an infinite number of intermediate values between negation and affirmation.

In this sense it is justified to speak about many-valuedness as long as one realizes that these intermediate values are not strictly formal but that they imply a contingent [assigned] meaning [content] as it was pointed out by Oskar Becker.

It is obvious that this kind of many-valuedness only is of minor advantage for an interpretation of the Hegelian logic because Hegel´s logic represents a theory of pure structures. There is also a second meaning of ´many-valuedness´ as it was introduced into logic by the author of the present article in the fifties. In this case the additional values are not located between negation and affirmation but beyond the antithesis of negation and affirmation. These values serve for the purpose to form new logical domains while the classical two-[or many-]valued logical domain remains intact.

We will illustrate what we mean using the classical conjunction as a simple example. For our demonstration we will not use the Boolean symbolism but instead we will use the natural number 1 for the affirmation - as it is practice in several studies of many-valuedness – and for the negation we introduce the following natural numbers (2, 3, 4, ...). Since we will discuss only some relative elementary cases of the Hegelian negation we will limit the number of values to 1, 2, and 3. We also need a minimum of two variables p and q and a sign for the conjunction: &. The classical conjunction has the form as given in the following table:

p	q	p & q
1	1	1
2	1	2
1	2	2
2	2	2

Diese Form der Konjunktion ist für den totalen Bereich einer geschlossenen ontologischen Kontextur gültig. In der klassischen Tradition ist die ganze Wirklichkeit eine solche einheitliche Kontextur, weshalb sie eine Struktur hat, die formal ausschließlich durch Zweiwertigkeit beschrieben wird. Damit ist implizit angenommen, daß die Elementarstruktur der Welt relativ einfach ist.

Wir wollen jetzt aber mit Hegel voraussetzen, daß die Welt kontexturelle Brüche enthält und letztlich eine Synthese sich gegenseitig ausschließender Kontexturen ist. Jede dieser Kontexturen ist intrakontexturell, d.h. inhaltlich wieder zweideutig. D.h., in allen gilt die klassische Logik lokal. Aber die klassische Logik gilt nicht für den trans-kontexturellen Übergang von einer gegebenen ontologisch-kontexturellen Lokalität zur nächsten. In andern Worten: eine logische Konfiguration wie die unseres konjunktiven Beispiels von p & q muß für jede Kontextur separat wiederholt werden.

Wenn wir jetzt zu den beiden klassischen Kontexturen von Sein und Nichts noch eine dritte, die wir nach Hegelschem Vorbild das Werden nennen können, einführen, dann ergibt sich ein konjuktives Muster für eine dreiwertige Logik, das die folgende Form hat:

This form of the conjunction is valid for the total range of a closed ontological contexture. In the classical tradition the reality is described by such a homogeneous contexture. Therefore it has a structure which is represented exclusively by the many-valuedness. With that it is supposed [postulated] that the elementary structure of the [description of the] world is relative simple.

Now we want to presuppose with Hegel that our world contains contextural breaks and may be considered as a synthesis of mutually excluding contextures. Each of these contextures is characterized intra-contexturally (i.e., with regard to contents) by its two-valuedness. I.e., within each contexture the rules of the classical logic are valid locally. However, the classical logic does not hold for any trans-[or inter]-contextural transition from a given ontological-contextrural location to another one. In other words, a logical configuration of p & q, as given in our example, has to be repeated separately within each contexture.

If we now introduce a third contexture to the two classical contextures of Being and Nothing which according to Hegel we be called Becoming, then there results a conjunctive pattern for a three-valued logic as depicted in the following table:

p	q	p & q	1 ↔ 2	2 ↔ 3	1 ↔ 3	1 ↔ 2 ↔ 3
1	1	W	1		1	1
2	1	?	2			2
3	1	F			3	3
1	2	?	2			2
2	2	?	2	2		2
3	2	F		3		3
1	3	F			3	3
2	3	F		3		3
3	3	F		3	3	3

Diese Tafel gibt angeblich eine einheitliche dreiwertige Konjunktion, wenn wir den Wert 1 als positiv = wahr (W), den Wert 3 als klassisch negativ = falsch (F) und den Wert 2 als Wahrscheinlichkeit von unbestimmter Größenordnung einsetzen, für die wir noch (als Symbol für das funktionelle Resultat) das Zeichen: ? einführen wollen. Die erste ungebrochene neunstellige Wertfolge auf der rechten Seite des vertikalen Doppelstrichs gibt dann eine konjunktive Wahrscheinlichkeitsfunktion, die sich innerhalb einer geschlossenen ontologischen Kontextur hält.

Nehmen wir aber an, daß wir es mit einer diskontexturellen Wirklichkeitsstruktur zu tun haben, dann ergibt sich aus den möglichen Wertkonstellationen der beiden Variablen p und q überhaupt keine einheitliche logische Funktion im klassischen Sinn, sondern unsere Tafel liefert uns drei zweiwertige Funktionen für die Konjunktivität, die sich auf verschiedene Kontexturen beziehen, in denen unsere traditionelle klassische Logik mit den drei Wertpaaren

1 ↔ 2
2 ↔ 3
1 ↔ 3

auftritt. Diese drei separaten Zweiwertigkeiten erscheinen nun in einem dreiwertigen System in einem transkontexturellen Zusammenhang, der uns erlaubt, sie in einer geschlossenen Wertfolge

1 ↔ 2 ↔ 3

Allegedly this table represents a uniform three-valued conjunction if we insert the value 1 as positive = true (W), the value 3 as the classical negative = false (F), and the value 2 as probability of an uncertain significance using the symbol "?" for the functional result. The first unbroken nine-placed sequence of values on the right hand side of the vertical double line then indicates a conjunctive probability function which holds within a closed ontological contexture.

Now if we assume that we are confronted with a discontextural reality then from a classical point of view, there is no consistent logical function resulting from the possible constellations of values from both variables p and q. Instead, our table delivers three two-valued functions for the conjunction which are related to different contextures each characterized by the validity of the classical traditional logic with three pairs of values:

1 ↔ 2
2 ↔ 3
1 ↔ 3

These three separate two-valued systems now appear in three-valued system in a trans-[inter-]contextural connection which allows us to represent them in a closed sequence of values, viz.,

1 ↔ 2 ↔ 3

darzustellen, wie die obige Tafel zeigt.

Die transkontexturelle Funktion der Mehrwertigkeit kommt aber dann am besten zum Ausdruck, wenn wir einen neuen Funktionsbegriff einführen, den wir 'Transjunktion' (Tr) nennen wollen, weil er jenseits der klassischen Dualität von Konjunktion und Disjunktion liegt.

In einer Welt, deren Wirklichkeitsstruktur diskontexturell ist, müssen wir annehmen, daß es Kontexturen von geringerer und größerer inhaltlicher Kohäsion gibt, und daß Werte aus stärkeren Kontexturen in den Bereich schwächerer Kontexturen störend eindringen können. Um diese logische Eigenschaft, die zum ersten Mal in einem triadischen System auftritt, zu illustrieren, zeigt die folgende Tafel den Wertverlauf einer Transjunktion. Der Wertverlauf ist erst in geschlossener Folge gegeben und dann separat für die drei Kontexturen, auf die sich unser triadisches System bezieht. Wir sehen, daß hier in das zweiwertige System

$$1 \leftrightarrow 2$$

der Wert 3 aus den anderen Kontexturen an derjenigen Stelle eingebrochen ist, die kontexturell am schwächsten ist, weil die Variablen in ihrer Wertbesetzung differierten. Wie man sieht, trägt die eine Variable jeweilig den Wert 1, wenn die andere den Wert 2 hat. Die Bedeutung des transjunktiven Einbruchs ist nun darin zu sehen, daß das Auftreten des Werts 3 eine Verwerfung der Totalalternative darstellt, durch die die gesamte Kontextur, in die der Einbruch erfolgt, charakterisiert wird. Der Wert 3 stellt also in diesem Falle ein ontologisches Novum dar. Und damit sind wir auf dem Weg über einige strukturtheoretische Überlegungen zu der Hegelschen Kategorie des Neuen zurückgekehrt.

This is demonstrated by the table given above.

The trans-contextural function of the many-valuedness is expressed best if we introduce a new function which we will call "transjunction" (Tr) because its range lies beyond the classical duality of conjunction and disjunction.

In a world whose structure of reality is discontextural, we have to assume contextures of a more and less coherence of contents and that values of stronger contextures may permeate weaker contextures in a disturbing way. In order to demonstrate this logical feature which appears for the first time within a triadic system, the following table lists the sequence of values for the transjunction. First, the sequence of values is given in closed form and then separately for the three contextures on which our triadic system is related. We can see that in the value 3 of the other contextures has permeated into the two-valued system

$$1 \leftrightarrow 2$$

The two-valued system $1\leftrightarrow2$ represents the contextural weakest system because its variables differ in valuation. The transjunctional permeation indicates a rejection of the total alternative [within the $1\leftrightarrow2$ contexture] caused by the appearance of the value 3 that characterizes the complete contexture in which the permeation occurred. In this case the value of 3 represents an ontological novelty. On our way of a structural-theoretical analysis we returned to Hegel´s category of the new.

p	q	p Tr q	1 ↔ 2	2 ↔ 3	1 ↔ 3
1	1	1	1		1
2	1	3	3		
3	1	2			2
1	2	3	3		
2	2	2	2	2	
3	2	1		1	
1	3	2			2
2	3	1		1	
3	3	3		3	3

Das für das System 1↔2 Gesagte gilt selbstverständlich auch für die Kontexturen, die durch 2↔3 und 1↔3 bezeichnet sind. Die oben angeführte Transjunktion ist total. Sie tritt ausnahmslos an allen Stellen auf, an denen die Möglichkeit besteht, eine auf p und q verteilte Wertalternative zu verwerfen. In dem System 2↔3 wird die Verwerfung sinngemäß durch den Wert 1 und in dem System 1↔3 durch den Wert 2 geleistet. Das gesamte dreiwertige System enthält aber selbstverständlich auch Funktionen, in denen eine solche Verwerfung nur für eine oder für zwei Kontexturen auftritt. Schließlich ist es möglich, daß die Verwerfung intrakontexturell-partiell ist; d.h., sie mag auftreten, wenn z.B. p den negativen Wert hat, aber nicht, wenn der negative Wert von q getragen wird. Da wir generell das Auftreten eines Rejektionswertes, der eine Wertalternative verwirft, als den logischen Index des ontologisch Neuen bezeichnet haben, ergibt sich aus dem eben Gesagten, daß wir vermittels der Mehrwertigkeit Intensitätsgrade des Neuen definieren können.

Der Verfasser hat in anderem Zusammenhang den transjunktiven Einbruchswert 3 in die Kontextur eines zweiwertigen Weltsystems mit den Werten 1↔2 als Index der Subjektivität in einer anderweitig subjektlosen Welt bezeichnet. Aber das sekundäre Auftreten der Subjektivität gegenüber dem primordialen Objekt ist nur ein Spezialfall des Neuen. Die Kategorie des Neuen selbst, von der Hegel spricht, ist von viel umfassende-

All arguments given for the system 1↔2 also hold for the contextures labeled as 2↔3 and 1↔3. The transjunction as given above is total, it appears without exceptions at those positions where the possibility exists to reject the distribution of alternative values for p and q. Within the system 2↔3 the rejection is executed by the value 1 and within 1↔3 by the value 2, respectively. The complete three-valued system also contains functions where such rejections only occur in one or two contextures. It is also possible that a rejection is intracontextural of partial character, i.e., it occurs, for example, if p has a negative value but not if the negative value belongs to q. Since we have attributed the appearance of the rejection value that discards an alternative of values as the logical index of the ontological new it follows that by means of the many-valuedness it is possible to define degrees of intensity of the new.

Within another context the author has designated the transjunctional value of permeation 3 into a contexture of a two-valued world system 1↔2 as an index of subjectivity in differently valued subject-free world. However, the secondary appearance of subjectivity towards the primordial object is only a special case of the new. The category of the new itself is of much more comprehensive generality. Its structural character will be accessible if we are studying many-valued sys-

rer Allgemeinheit. Ihre Struktureigenschaften sind uns zugänglich, wenn wir mehrwertige Systeme studieren, in denen Mehrwertigkeit nicht intra-kontexturell gedeutet werden kann.

tems where many-valuedness cannot be interpreted any longer [exclusively] as an intra-contextural formalism.

APPENDIX 2

Wenn im Text gesagt worden ist, daß Hegels "zweite Negation" nur ein Sammelbegriff für eine Hierarchie transklassischer Negationsstrukturen ist, so erfordert das eine nähere Erklärung.

Wir definieren ein Negationssystem - sei das klassische oder ein transklassisches - als eine Permutationsordnung der im System verfügbaren m Werte. Die Zahl der möglichen Permutationen ist dabei immer m!; also in dem uns vertrauten klassischen System 2. In einem dreiwertigen System wären das 6 und in einer vierwertigen Struktur 24, denn 4! = 24

Diese Permutationen gehören zu unterschiedlichen Klassen, deren Verteilung sich aus den Moduli der Stirlingzahlen der ersten Art s(m,k) ablesen läßt. Die Tafel dieser Moduli von m = 1 bis m = 7, hat die folgende Gestalt:

In the text it has been argued that Hegel´s "second negation" represents only a comprehensive term for an hierarchy of trans-classical negational structures. This argumentation certainly needs some further explanation.

We will define a system of negations – classical or transclassical – as an order of permutations of the values m available within the system. The number of possible permutations is given always by m!, i.e., within the well known classical system the number of permutations is 2. Within a three-valued system this value is 6 and within a four-valued system it is 24, namely 4! = 24.

These permutations belong to different classes whose distribution may be deduced from the moduli of the Stirling numbers of first kind s(m, k). The table for these moduli from 1 to 7 us given as follows:

m \ k	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**m!**
1	1							1
2	1	1						2
3	2	3	1					6
4	6	11	6	1				24
5	24	50	35	10	1			120
6	120	274	225	85	15	1		720
7	720	1764	1624	735	175	21	1	5040

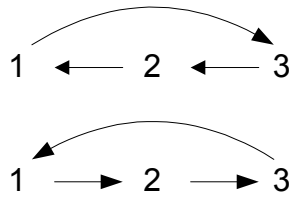
Um die Bedeutung der Tafel zu erläutern, stipulieren wir, daß m wieder die Zahl der Werte angibt und k die Zahl der Zyklen, auf die die Werte verteilt werden können. Statt von Zyklen können wir auch von speziellen Abbildungen sprechen. (Es sei nebenher bemerkt, daß die traditionelle Hegelinterpretation bisher an der Tatsache vorbei gegangen ist, daß, wenn Hegel von Kreisen und einem Kreis von Kreisen spricht, sich das als Reden über spezifische Abbildungssituationen deuten läßt). Für ein einwertiges System existiert selbstverständlich nur eine Abbildung, in der der einzig vorhandene Wert auf sich selbst abgebildet ist (Auto-referenz). Verfügen wir über zwei Werte, so existieren zwei solcher Abbildungsmöglichkeiten. Entweder kann jeder Wert auf sich selbst abgebildet werden oder auf den anderen. Mit dem Auftreten von drei Werten kommt der Begriff des Kreises oder Zyklus in sein volles Recht, denn erst in diesem Fall wird der Richtungssinn der Kreisbewegung relevant.

Wir geben anschließend die zyklischen Schemata, die einem dreiwertigen System entsprechen:

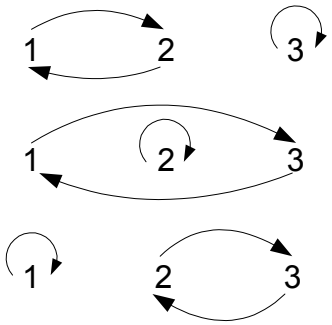
In order to explain the meaning of this table we stipulate that m again stands for the number of values and k for the number of cycles on which the values can be distributed. Instead of cycles we also can speak about special figures. (It should be mentioned that the traditional Hegel interpretation has not yet realized the fact that if Hegel speaks about circles and a circle of circles that this can be interpreted as a talk about a special mapping situation). For one-valued system there exists only one figure where the only existing value is focused on itself (auto-reference). For two values there two ways for a mapping: Either each value is focused on itself or it focused on the respective other. If there are three values the meaning of a circle (or cycle) gets its full meaning because in this situation the direction of the circulatory is of relevance.

In the following figures the cyclic schemes are depicted which correspond to a three-valued system:

ein Zyklus | one cycle :



zwei Zyklen | two cycles :



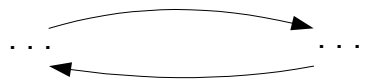
drei Zyklen | three cycles:

Das entspricht den korrespondierenden Zahlen 2, 3 und 1 der Tafel der Moduli von s(m, k). D.h., wir begegnen in einem dreiwertigen System zwei echten "Kreisbewegungen" der Werte. Eine, in der sich die Werte im Uhrzeigersinn und eine, in der sie sich gegenläufig dazu bewegen. Im Falle von zwei Zyklen bestehen drei Möglichkeiten, je nachdem, welchen Wert wir als "Selbstzyklus" (unit cycle) auftreten lassen. Die dann übrig bleibenden Werte formen somit logische Umtauschverhältnisse, die hier ebenfalls als Zyklen bezeichnet werden, obwohl die Umkehrung des Richtungssinns der "Kreisbewegung" nichts Neues ergibt. Im letzten Fall schließlich haben wir es mit drei Selbstzyklen zu tun, für die es selbstverständlich, im Gegensatz zu den vorangehenden Fällen, nur eine Version gibt.

Jeder Selbstzyklus stellt eine Elementarkontextur dar. Das gleiche gilt von einem Zyklus, der nur durch zwei Werte hindurchläuft, also die folgende Gestalt hat:

These figures correspond to the numbers 2, 3 and 1 listed in the table of moduli of the Stirling numbers s(m,k). I.e., we meet within a three-valued system two real "circular motions" of values: one clockwise and one anticlockwise. In the case of two cycles there are three possibilities depending on the value which we select as "unit cycle". The rest of the values constitute a exchange relation which also have been labeled as cycles despite the fact that the inversion of the circular motion reveals nothing new. In last case we are opposed with three self-cycles and obviously there exists only one version.

Every self-cycle represents a elementary contexture. The same holds for a cycle which passes only two values and which has the following shape:



Der Unterschied zwischen einer Elementar-Kontextur als Selbstzyklus und einer Elementar-Kontextur, die über zwei Werte distribuiert ist, besteht darin, daß im ersten Fall besagte Kontextur als "reflexionsloses Sein" (Hegel) und das andere Mal als zweiwertiges Reflexionsbild verstanden wird. D.h., wir besitzen zwar jetzt ein zweiwertiges System, aber das Thema der Reflexion ist strikte Einwertigkeit, die allein thematisch ist. Der jeweilig zweite Wert kommt als ontologisches Thema, d.h. kontexturell, nicht zum Zug. Er ist nicht designierend. Oder in Hegelscher Terminologie: er designiert das Nichts.

Diese kalkültheoretische Doppelsinnigkeit des Begriffs der Elementar-Kontextur ist genau das, was wir benötigen, wenn wir beabsichtigen, die Dialektik zu formalisieren. Einwertigkeit und Zweiwertigkeit referieren beide auf Elementar-Kontexturen, aber in sehr verschiedenem Sinne; in einem Sinne aber, der durch die Unterscheidung von Einwertigkeit und Zweiwertigkeit exakt ausdrückbar ist. Gehen wir zu einem dreiwertigen System über, dann begegnen wir zum ersten Mal einer Struktur, die wir von jetzt ab als "Verbundskontextur" bezeichnen wollen. Das klassische zweiwertige System repräsentiert noch keine Verbundskontextur, weil der Isomorphiecharakter dieses Systems den zweiten Wert nur als reflektierte Wiederholung des ersten auftreten läßt. Der zweite Wert liefert also nichts Neues, und überdies steht er dem ersten unvermittelt gegenüber. Verbundskontextur aber bedeutet Vermittlung. Eine solche Vermittlung aber involviert nun nach Hegel eine "zweite" Negation.

Um festzustellen, was man unter dem Hegelschen Terminus zweite Negation kalkültheoretisch allein verstehen kann, stellen wir im folgenden eine zweiwertige und eine dreiwertige Negationstafel auf, wobei wir nochmals darauf hinweisen, daß wir eine Negation als Permutation der gegebenen Werte auffassen. Das ergibt für eine beliebige Variable p im Falle von zwei Werten die einfache Tafel:

p	**N_1 p**
1	2
2	1

Diese Tafel der klassischen Negation (hier bezeichnet als N_1 ...) stellt nichts weiter dar als ein symmetrisches Umtauschverhältnis von Positivität und Negation überhaupt. Da in der klassischen Logik von Diskontexturalität überhaupt noch nicht die Rede ist und das Universum als mono-kontextural betrachtet wird, arbeitet der Negationsoperator natürlich innerhalb dieser einzig vorgegebenen

The difference between an elementary contexture as self-cycle and an elementary contexture distributed over two values consists in the fact that in the first case the contexture is understood as "reflexionless Being" (Hegel) and in the second case it is understood as two-valued image of reflection. This means, that we are now provided with a two-valued system but the theme of reflection which is thematic still is of strict one-valuedness. The corresponding second value does not get any chance as an ontological theme, i.e., as contexture. This value is not designating, or in Hegel´s terminology: it designates the Nothing.

It is just this (calculus) theoretical equivocation of the concept of an elementary contexture what is necessary in order to formalize the dialectic [principles]. Both, one-valuedness and two-valuedness refer to elementary contextures but in a somewhat different meaning which can be determined exactly by the distinction of the valuedness. The three-valued structure offers the possibility to define a so-called "compound contexture". Caused by the isomorphical character no such compound contexture can be defined within a classical two-valued system because where the second value only occurs as reflected repetition. Therefore the second value delivers nothing new. Furthermore the second value is confronted without any mediation to the first value. However, compound contexture means mediation. According to Hegel, such a mediation involves a "second" negation.

In order to find out what the Hegelian "second negation" means in terms of a theoretical calculus we will develop in the following a two- and three-valued negation table. In this context we like to point again to the fact that we consider a negation as permutation of the given values. For an arbitrary variable p with two values it follows:

p	**N_1 p**
1	2
2	1

This table simply represents the classical negation (labeled as N_1) and it reveals the symmetrical exchange relation of affirmation and negation-in-general. Since discontexturality cannot exist within a classical mono-contextural logic the negation operator only functions within the single given contexture. Now, if add a further value 3 and if stipulate that again a

Kontextur. Fügen wir jetzt einen weiteren Wert 3 hinzu und stipulieren wir, daß zwischen ihm und seinem Vorgänger 2 sich wieder ein symmetrisches Umtauschverhältnis ergibt, das durch den Negationsoperator N_2... aktiviert werden soll, dann erhalten wir die folgende Tafel,

p	**N_2 p**
2	3
3	2

die mit der vorangehenden Tafel strukturell identisch ist. Fügt man die beiden Tafeln aber zusammen zu einem dreiwertigen Negationssystem, so ergibt sich die erweiterte Negationsstruktur

symmetrical exchange relation exists between this new value and its predecessor 2 which will be activated by the negation operator N_2 then the following table results:

From a structural point of view this table is identical to the previous one. If we connect both table a three-valued negation system results with the following expanded negation structure:

klassisch		trans-klassisch				
p	**N_1**	**N_2**	**$N_{2.1}$**	**$N_{1.2}$**	**$N_{1.2.1}$**	**$N_{2.1.2}$**
1	2	-	2	3	3	3
2	1	3	3	1	-	-
3	-	2	1	2	1	1

trans-klassisch

in dieser aus 6 vertikalen Kolonnen bestehenden Tafel haben wir erstens die ursprüngliche klassische Negationstafel links oben von den transklassischen Negationsfolgen durch Doppelstriche abgegrenzt. Und zweitens haben wir jede vertikale Wertfolge durch die Negationsoperation (N ...) gekennzeichnet, durch die sie erzeugt wird. Wir bemerken, daß Kolonne 2 und 3 von links durch ein einzige Negationsoperation erzeugt werden. Für Kolonnen 4 und 5 sind zwei Negationsoperationen notwendig, und die letzte Kolonne benötigt drei, kann aber, wie man sieht, auf zweierlei Weise erzeugt werden. Diejenigen Werte, die sich relativ zu der Ausgangswertfolge 1, 2, 3 (ganz links) nicht verändern, sind in den Kolonnen nicht angeschrieben, sondern durch einen Horizontalstrich ersetzt worden. Wir stellen fest, daß in der ersten Negationsoperation, in der wir mit dem klassischen Operationsoperator allein arbeiten, der Wert 3 nicht berührt wird. In der trans-klassischen Operation N_2, die das Umtauschverhältnis der Werte 2 und 3 aktiviert, bleibt der Wert 1 unangetastet. In den Operationen $N_{2.1}$ und $N_{1.2}$, in denen eine vollzogene einfache Negationsoperation nochmal durch den jeweilig anderen Negationsoperator negiert wird,

This table which is composed of six columns shows the classical negation that has been separated from the trans-classical negation sequences by a double bar. Second, each sequence of values has been marked by the negation operator (N_i ...) which generated the sequence. The sequences of column 2 and 3 has been generated by one negational operation while for the generation of column 4 and 5 two such operations are necessary, and three operations are required for the sequence in column 6. From the values in column 6 and 7 it can be seen that they can be generated in two different ways. Those positions where the values have not changed as compared to starting values (column 1) are marked by a dash. The trans-classical operation N_2 that activates the exchange relation of the values 2 and 3 leaves the of 1 untouched. The operations $N_{2.1}$ and $N_{1.2}$ where an already performed single negation is repeated by the corresponding other negation respectively, all values of the original sequence 1, 2, 3 have changed. In the first of the two sequences (column 6) the change occurs clockwise and anticlockwise in the second case (column 7). In both columns 6 and 7 the value 2 keeps

werden alle drei Werte der ursprünglichen Wertfolge 1, 2, 3 verändert. Im ersten der beiden Fälle bewegen sich die Werte zyklisch im Uhrzeigersinn und im zweiten Fall gegen den Uhrzeigersinn. In der sechsten, also letzten Kolonne bleibt wieder ein Wert, nämlich 2, konstant, dafür aber haben wir diesmal einen Umtausch der Werte 1 und 3.

Wir behaupten nun, daß das, was Hegel unter "zweiter Negation" versteht, sich, soweit Dreiwertigkeit in Frage kommt, auf die gesamte Wertstruktur bezieht, die außerhalb des klassischen Negationsbereiches, der links oben durch Doppelstriche abgegrenzt ist, liegt. Fügt man dann noch einen vierten, fünften, sechsten usw. trans-klassischen Wert hinzu, dann erweitert sich jener trans-klassische Strukturbereich ganz enorm, und wir verfügen dann über einen theoretisch unbeschränkten Bereich von Negationsrelationen, der den feinsten Verästelungen des dialektischen Fortgangs in der Hegelschen Logik entspricht.

In dieser ersten und einfachsten trans-klassischen Negationstafel spielt nun der Wert 2 eine vermittelnde Rolle zwischen 1 und 3. Das läßt sich vielleicht am besten zeigen, wenn wir etwas näher auf den Charakter des Umtauschverhältnisses der Werte 1 und 3 eingehen. Wie wir jetzt wissen, kann dieses Umtauschverhältnis durch den Operator $N_{1.2.1}$, aber auch durch den Operator $N_{2.1.2}$ aktiviert werden. Die obige transklassische Negationstafal gibt das "abstrakte" Resultat, das in beiden Fällen gleich ist. Da die Hegelsche Logik aber das Problem der Zeit einbezieht (und die Vermittlung ist wesentlich ein Problem der Kombination von Zeit und zeitloser Logik) muß uns die Genese dieses Resultats wichtig sein. Aus diesem Grunde schreiben wir die obige transklassische Negationstafel noch einmal hin, aber diesmal so, daß uns das abstrakte Resultat eines Umtausches der Werte 1 und 3 in zwei Versionen erscheint.

unchanged while for the values 1 and 3 an exchange occurs.

So far as three-valuedness is concerned, we state that the meaning of Hegel´s "second negation" is related to the complete structure of values that occurs outside the classical negation which has been marked out by a double bar. If further values (a fourth, fifth, ... , etc.) are added the trans-classical range will be enlarged enormously and in principle an unlimited range of relations of negations is opened which corresponds to the most delicate branching of the dialectical progress in the Hegelian logic.

In the foregoing simplest form of a trans-classical table of negation the value 2 plays a mediating role, i.e., it mediates between the values 1 and 3. As we already know, the exchange relation between the two values 1 and 3 can be activated either by the operator $N_{1.2.1}$ or by $N_{2.1.2}$. The trans-classic table or negation given above reveals the "abstract" result which is identical for both cases. However, Hegel´s logic includes the problem of time and the mediation mainly is a problem of combining time and timeless logic. Therefore the g e n e s i s of this result is of some importance for our discussion. For this reason we rewrite the trans-classical table of negation in a way that the two versions of the exchange of the values 1 and 3 appear.

	klassisch		trans-klassisch				
p	**N_1**	**N_2**	**$N_{2.1}$**	**$N_{1.2}$**	**$N_{1.2.1}$**	**$N_{2.1.2}$**
1	2	-	2	3	-	3
2	1	3	-	-	2	2
3	-	2	1	2	1	-

trans-klassisch

Wie man sieht, erscheinen in der neuen Tafel die leeren, nur durch einen Horizontalstrich

As one can see from the table, the places which are marked by a dash appear at

bezeichneten Plätze an anderen Stellen. Außerdem hat sich ihre Zahl vergrößert. Das haben wir dadurch erreicht, daß wir diesmal unsere Horizontalstriche nicht dort gesetzt haben, wo ein Wert relativ zu der ursprünglichen Wertfolge in der Ersten Kolonne von links unverändert bleibt. Diesmal haben wir als "ursprüngliche" Wertfolge jeweils diejenige Wertfolge angenommen, die durch den letzten Operationsnegator verneint wird. Das sind im Falle der allerletzten Wertfolge 3, 2, 1 die beiden echten zyklischen Wertfolgen 2, 3, 1 und 3, 1, 2. Je nachdem, welche Negationsoperation man bevorzugt, bleibt ein anderer Wert konstant. D. h., in dem ersten der beiden Fälle befindet sich unser Horizontalstrich in der obersten, im zweiten aber in der untersten Position. Wir begegnen hier also wieder der für die Dialektik erforderlichen Doppeldeutigkeit einer logischen Funktion.

Das dreiwertige System ist das erste und elementarste Beispiel einer Verbundkontextur. Aber ebenso wie der Übergang vom einwertigen zum zweiwertigen System keine neue Kontextur produziert, so reicht der Übergang von einem dreiwertigen zu einem vierwertigen System keineswegs aus, um eine dritte Verbundkontextur zu erzeugen.

Die nächst höheren Verbundkontexturen werden durch die Wertzahlen 6, 10, 15, 21, 28, ... angezeigt, d.h., ihre Folge ist berechenbar durch die Formel

$$\frac{m(m-1)}{2}$$

(Vgl. dazu die Arbeit des Autors: Many-valued Designations and a Hierarchy of First Order Ontologies, XIV. Internat. Kongreß f. Philos. 1968, 111, 37 - 44, wo die Kontexturen noch 'Ontologien' genannt werden.)

Ein System wird erst dadurch zu einer Kontextur, daß sich aus ihm keine Werte als nicht-designierend abspalten lassen. Nicht-designierende Werte indizieren ein Bewußtsein, daß seinen Gegenstand sich gegenüber hat. Damit aber ist die Situation der Diskontexturalität gegeben. Die obige Formel gibt also an, wieviel Elementarkontexturen jeweilig zusammenkommen müssen, damit eine Verbundkontextur entsteht. Weiterhin läßt sich damit sagen, daß die Hegelsche "zweite Negation" nur im ersten Schritt (also beim Übergang vom zweiwertigen klassischen zum dreiwertigen System) aus einem einzigen Negationsoperator besteht. Bei dem Übergang zu komplexeren Verbundkontexturen erhöht sich die Zahl dieser Operationen, die jeweilig

different position and their number increased. The reason for this results from the fact that this table has been constructed in slightly different as compared to the foregoing table of negation. In the foregoing table the dashes correspond to those values which have not changed during the negational operation if compared to the values of the first column. In our new table the dashes symbolize the places where no changes occur in comparison to the last negational operation. For example, in the case of column 6 it is the sequence of 3, 1, 2 which changes during the last operation of $N_{1.2.1}$ into the sequence 3, 2, 1 This has been symbolized in the table by the sequence: - , 2, 1. As can be seen in the table, the results differ for the two operators $N_{1.2.1}$ and $N_{2.1.2}$ which again demonstrates the equivocation of a logical function necessary for the modeling of dialectic processes.

The three-valued system is the first and the most elementary example of a compound contexture. But in the same way as the transition from a one-valued to a two-valued system produces no new contexture the transition from a three- to a four-valued system also is not sufficient to create a third compound contexture.

The next compound contextures are generated in systems with a number of values of 6, 10, 15, 21, 28, ... This sequence can be calculated by the following formula

$$\frac{m(m-1)}{2}$$

(cf. the auhor´s study: Many-valued Designations and a Hierarchy of First Order Ontologies, XIV. Internat. Kongreß f. Philos. 1968, 111, 37 – 44. In this study the instead of contextures the author still used the term ´ontologies´)

A system becomes a contexture only if it is not possible to separate non-designated values from the contexture. Non-designated values indicate a consciousness opposed to an object. Thus the discontexturality is given. The formula given above gives the number of elementary contextures necessary in order to create a compound contexture. Furthermore it can be stated that Hegel´s "second negation" is composed of one negation only in the first step, i.e., from the transition of a tow-valued classical system to a three-valued trans-classical system. For the transition to more complex compound contextures the number of operations that produce a exchange relation

ein Umtauschverhältnis $m \rightleftarrows m+1$ erzeugen, sinngemäß nach der Formel

$$\frac{m(m-1)}{2} - 1$$

Betrachten wir die Kategorie des Neuen jetzt unter strukturtheoretischen Gesichtspunkten, so läßt sich sagen, daß die Systemfolge der Strukturen, welche mit 1, 3, 6, 10, 15, 21, 28 usw. Werten gebildet werden, insofern immer Neues produziert, als sich in jedem dieser Systeme der Objektbereich je um eine Objektklasse vergrößert. Im ersten System begegnen wir selbstverständlich nur einer einzigen Menge der einwertigen Objektklasse. Im dreiwertigen System tritt dann eine zweite Klasse hinzu, die nur durch das Umtauschverhältnis zweier Werte definiert werden kann. Im sechswertigen System begegnen wir zum ersten Mal einer Objektivität von echter zyklischer Natur. Aber während in einem solchen System der Zyklus, der diese Objektklasse von den beiden vorangehenden absondert, nur durch jeweilig drei Werte hindurch läuft, treten in dem nächst höheren, nämlich in dem zehnwertigen System bereits zwei solcher zyklischer Objektklassen auf, von denen sich die letztauftretende von der vorangehenden dadurch unterscheidet, daß jetzt der Zyklus einen Wert mehr durchläuft. Das impliziert jedesmal ein strukturtheoretisches Novum. Soll ein weiteres theoretisches Novum auftreten, so muß zu den bisherigen Systemen ein zusätzliches treten, das alle bisherigen Systeme dadurch übertrifft, daß in ihm Zyklen auftreten, die noch einen Wert mehr durchlaufen, wenn eine separate Gegenstandsklasse, die bisher noch nicht aufgetreten ist, beschrieben werden soll.

Was unser Essay und seine beiden Appendices liefern, ist noch sehr entfernt von einer durchgeführten Theorie der Kategorie des Neuen und seiner Selbstvermittlung durch das Alte im Lauf der Geschichte, Der Autor hat sich damit bescheiden müssen anzudeuten, nach welchen Gesetzen der Strukturreichtum der Wirklichkeit zu wachsen scheint, wenn im Laufe der Zeit ein Neues an die Stelle des Alten tritt.

$m \rightleftarrows m+1$ according to the following formula

$$\frac{m(m-1)}{2} - 1$$

If we consider the category of the new from a structural-theoretical point of view then it can be stated, that sequence of systems composed by structures with values of 1, 3, 6, 10, 15, 21, 28 etc. are producing something new in the sense that within each system the range of objects increases by one class of objects, respectively. Within the first system there is only one set of a one-valued class of objects. Within the three-valued system a second class appears which can be defined by the exchange relation or two values. Within a six-valued system for the first time an objectivity appears which is characterized by a real cyclic nature. But while the cycle within this system, which separates this class of objects from the two preceding, transfers only three values, the number of cyclic classes of objects increases with higher values. Within a ten-valued system, for example, there are already two cyclic classes of objects where the new appearing class differs from the preceding one by the fact that it passes one more value and so on. From a structural point of view each time if this appears it implies a *novum*. So if a further theoretical *novum* should be generated an additional system has to appear which exceeds its predecessors by the number of values which are passed by the cycles within the system. This is necessary in order to describe a separate class of objects which have not appeared in the preceding classes.

What we have discussed within our essay and its two appendices is still far away from any performed theory of the category of the new and a self-mediation of the old in the course of history. The author had to satisfied to outline shortly the growth of laws responsible for the richness of structure if in the course or time the new replaces the old.

vordenker
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Gotthard Günther [*]

A New Approach to The Logical Theory of Living Systems

Let us begin with a mental experiment. We will assume a universe consisting of nothing but sounds, and a consciousness which is only aware of sounds and incapable of being aware of anything else, because there is nothing else in existence. This sound world we shall call a contexture, and the awareness of it a system of contexturality. A life existing in such a world might be a sequence of beautiful melodies interrupted by shrill dissonances. The concatenations of sounds which we call melodies we will name single contexts in contrast to the all-enveloping contexture of sound in general. The strange thing is that a conscious life existing in this world would paradoxically never know what 'sound' is because there would be nothing it could compare with sound. And we know things only by their differences from other things. Now let us assume another world which consists only of tastes like sweet, sour, bitter etc. and a consciousness whose life would exhaust itself completely in the awareness of different tastes. Again we could not explain to a consciousness living in this taste world what 'taste' is because taste is everything it knows. And these two worlds could not know anything of each other; a consciousness of mere tastes could never conceive what sound is, nor could a consciousness of nothing but sound understand if we talk to it about taste. Both are imprisoned in their respective contexturalities. Let us call these simple one-dimensional worlds elementary contextures.

However, there may be an creature that knows both taste and sound and can compare them from the vantage point of what we may call a compound contexture that comprises taste and sound. This creature would also have its world which for itself is an elementary contexture from which it cannot escape and outside which it cannot conceive anything in rational terms. In other words: what would be a compound contexture relative to taste or sound would be an elementary contexture relative to a level of consciousness that can compare isolated sound and taste within a more complex sound-taste world.

It cannot be too strongly emphasized that the distinction between elementary contexture and compound contexture is relative. And since we know from biological experience in the animal and human world that it is a place where we encounter organisms of ever increasing complexities capable of supporting systems of consciousness of steadily growing scope of awareness, we may say that the contextures we have been speaking of form a hierarchy such that every given contexture will be a compound contexture relative to the contextures below it but an elementary contexture relative to those above it.

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* (Vortragsnotiz Chicago 1972, unveröff. Manuskript)
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We shall now ask which is the contexture of greatest reach that the human consciousness can encompass. It is designated by the ontological term of Being-in-general. To be or not to be, that is the basic question – which means that nothing outside of Being or beyond it is conceivable to us. And exactly like the consciousness which lived in a world of mere sound and could therefore never conceive what a sound is, we do not know what Being is and how it ever came about, since there is nothing we can compare it with. The world in which we live is to us an elementary contexture because all the variegated properties of individual contexts are held in this encompassing universal contexture of Being-in-general. Nevertheless there is something excluded from it, namely a consciousness which conceives the totality of this world of objective Being which appears in our judgment as an elementary contexture.

This, of course, raises the question: where does this seemingly ultimate consciousness originate that conceives the existing world as a whole? The classic tradition of philosophy has an answer for it and so have the great world religions. Permit me to remind you of the answer as it is given in Plato´s Dialogue Phaidon. Socrates has been condemned to death and explains to his friends who are keeping him company during his last hours that he is not afraid to die, for the human soul which is the ultimate subject of cognizance is nothing but a temporary guest in this world. It enters this vale of tears at the time of birth and leaves the world again when the body dies. There is – so religious belief insists – outside of the total contexture of this empirical universe an unconceivable and unfathomable Beyond which is the home of the soul and of Life Eternal. The nature of this realm is not comprehensible in rational terms and only the longing for a better and higher world can reach out to it.

This, of course, is mere mythology for the scientist and rational thinker, although it is a beautiful one. But there is a tiny rational core in it which we shall now divest of its irrational adornments provided by our emotions. It is the age-old wisdom that Life is an phenomenon which is – as we shall call it – trans- or discontextural. It always transcends that which is objectively given. It is the basic difference between inanimate and merely objective systems on one side, and of living, subjectivity-endowed entities on the other side, that the first category, namely that of inanimate objects can always be described in the logical terms of an elementary contexturality; whereas living systems remain basically discontextural. It is an object; but it is also something utterly and inconceivably different from an object. There is no way to describe it as a contextural unit of thingness. We might say: it is a composition of different realms of merely potential objectivity where the actual objectivity of a specific domain may exclude the actualisation of another domain. The objectivity of – let us say – our human flesh and blood belongs to a different contexture than the subjectivity of the thoughts and concepts which our living awareness produces. And yet, what we perceive a mere subjectivity may be objective in a contexture of a higher order. Thus subject and object – although mutually discontextural – may belong to one and the same poly-contextural world. But the old distinction between body and soul is only a very crude example of the discontexturalities that pervade a living system. An organism is always a compound of a multitude of single contextures that are discontextural relative to each other. The functioning of the neurons of our brain belongs to a different contexture from that of the chemical processes inherent in our blood circulation. And these again are contexturally different from the mechanical activities of our muscles.

These general remarks should be sufficient to give a first, although a very vague thinking of what is meant by the terms contexture and contexturality. In order to be somewhat more precise let us now turn to a formal logical definition of contexture. A contexture is a logical domain which may be exhaustively described by the laws of two-valued logic. However, the application of these laws must be conducted in such general terms that the law of the Excluded Middle does not find a restricted application. Its validity must be universal. Normally we apply the law of the Excluded Middle in a non-universal and rather loose manner. If somebody says in a court of law: The defendant is either guilty or not guilty, it would be fictitious to remark: oh no – he is blond and broad shouldered. Which means that the alternative guilty or not guilty is confined to the isolated context of judicial concepts and excludes everything which does not belong to it. But a context, as we have pointed out before, is not a contexture. The contexture would include all those terms which the limited application of rule of the Excluded Middle prohibits. In the universal contexture the description of the defendant would indeed encompass such terms as blond, broad shouldered, married, sick and so on. The universal application of the law of the Excluded Middle would thus be an existential statement: The defendant is or exists as an embodiment of all these – practically infinite – properties which characterize his effective presence, or he is not. In other words: the universal application of the law of the Excluded Middle establishes the ultimate alternative between: something is or between something is not. In metaphysical terms: between Being and Nothingness. By having this effect the universal application of the Excluded Middle establishes the boundary of an elementary contexture. Because it is obvious that no description of what there is can continue beyond the limits of Being-in-general into the domain of Nothingness. Furthermore: since the two-valued logic defines the boundaries of a close contexture it excludes automatically that which is discontextural. And since discontexturality is the basic structural property of Life or Subjectivity, it means that a world described solely in terms of an two-valued logic provides us with the scientific picture of a subjectless universe.

This has been recognized many times. Permit me to quote just one outstanding scholar, the late physicist Erwin Schrödinger. In his Tarner lectures, delivered at Trinity College in the University of Cambridge, England, in 1959 and later on published as a monography titled 'Mind and Matter' Schrödinger remarked: "...our science – Greek science – is based on objectification, whereby it has out itself off from an adequate understanding of the Subject of Cognizance, of the Mind." (p.54 ff) And again Schrödinger: "Without being aware of it and without being rigorously systematic about it, we exclude the Subject of Cognizance from the domain of Nature that we endeavor to understand." (p.38) And finally, we find in the Tarner lectures the profound remark: "The reason, why our sentient percipient and thinking ego is met nowhere within our scientific world picture can easily indicated in seven words: because it is itself that world picture. It is identical with the whole and therefore cannot be contained in it as a part of it." (p.52)

Schrödinger´s last statement illustrates in an excellent way what we meant by the distinction between two contexturalities. First, the objective world itself as the sum of all things and their interlocking activities is conceived by us as a single contexture notwithstanding the fact that this environment of our is composed of an almost infinite amount of contextures of

lower order. Second, the image of this world as we produce it in our scientific theories belongs to a different contexture. And the only way in which according to Schrödinger the subject of cognizance can manifest itself to us, as long as we adhere to the habits of classic thinking, is the reflection of reality in our subjective concept of it. We become first aware of our subjectivity, by the fact that we have an image of our environment.

But two-valued classic logic defines – as we pointed out above – a single subjectivity represents a contexture of the lowest order. And since subjectivity of its own, it is automatically excluded from any two-valued theory of the universe we might have. On the other hand – and this is very confusing when first introduced to the theory of polycontexturality – taken as a single elementary contexture subjectivity must also be described by a two-valued logic and this logic in no way differs from the logic which we applied to perceive a subjectless universe. The point is, although it is in both cases the same logic and even the same technique of application, that it is of utmost importance we have to distinguish between the two applications. This means we must be able to state how they relate to each other.

The way to do so in precise structural terms is by introducing a multi-negational logic in such a way that this logic appears as a general place-value system for any number of two-valued logical structures. The places themselves which harbor such classic systems represent elementary contexturalities. Each appearance of a two-valued logic within the place-value System defines a single contexturality and the relations which these two-valued systems display within a multi-negational order produce the structural phenomenon which we call Poly-Contexturality. A subjectless universe, conceived in terms of absolute objectivity is, ontologically speaking, mono-contextural. On the other hand, a cosmos which we describe as a region that contains life must be considered to be poly-contextural. And not only that: every part of such cosmos which we recognize as a living organism must also considered to be poly-contextural.

At this point an important question should be answered: Since our classic two-valued logic has furnished a solid foundation for our sciences for more than two thousand years and since these sciences have produced admirable results, why should we change this classic basis at the present juncture? The answer is: because since several decades we have been trying to develop a new scientific discipline, called cybernetics which does not only want to theorize in abstract terms about the phenomenon of Life but which has the ultimate aim of designing analogues to life processes in terms of physical systems. This ultimate aim of cybernetics is not always clearly understood by some scientific workers who call themselves cyberneticists, but it is positively implied in Norbert Wiener´s famous work and in the researches of Warren S.McCulloch.

On the other hand, cybernetics is by no means the first scientific discipline to deal within the natural realm with the phenomenon of Life. But so far there has been no urgency to introduce new theories of logic into the field of biology proper. There is a good reason for it: although the term 'biological engineering' has frequently turned up in recent years there is a subtle but profound difference between the orthodox biologist and the engineer working in the field of cybernetics in general with special orientation towards biological computer theory. If a biologist works with amino-acids and protein molecules and experiments with

certain molecular configurations he does not pretend to produce Life in the laboratory by mechanisms of his own design, but he hopes that the modalities and capacities inherent in organic physical matter – if only combined in an appropriate way – will result in the emanation of life. But he himself, the biologist, will be merely the onlooker who observes what happens. In other words: the biologist intends to repeat, in a radically abbreviated manner, what our solar system did when it developed, in the course of cosmic history, from anorganic compounds into such material appearances as we call plants, animals and humans. The biologist follows basically the old homunculus theory of letting Life develop in the retort.

If the biologist ever succeeded, he would not be entitled to claim he had made Life, he could only take credit for having produced in a retort the necessary conditions to set in motion chemical processes that ended up in generating living matter. But this is not the way to obtain an answer to the question what Life really is. It would remain the secret of the inherent potentialities and powers of the material substance from which Life emerges.

The cyberneticist, in contrast to the attitude of the orthodox biologist, is guided by the epistemological principle of pragmatism that we only understand that which can make ourselves. In consequence, he does not want to be merely a more or less passive observer of the ways in which inanimate matter finally develops into living systems, but he wants to imitate as an engineer this phenomenon, or at least its functions, in a medium entirely of his own design. It is the medium we rather sloppily call hardware in cybernetics.

The scientific worker in this field will, of course, have to concede from the start, provided he is reasonable successful, that what he has produced is not Life per se (which is, at any rate, a metaphysical concept) but a specific mechanism which incorporate the various logical predicates necessary to analyze the phenomenon of Life. To put it differently: he will have succeeded in producing a machine which displays behavioral traits which we observe in living systems, but not in inanimate matter. Our cyberneticist may add: I do not know and, in fact, I do not care whether it would be possible to design a machine which is alive, but the mechanism I have produced, if perfect enough, might function in such way as if it were alive. And our cyberneticist might, furthermore, rightfully imply that he now understands what the term Life means up to the degree to which he was able to design behavioral traits of living bodies into his lifeless hardware.

It has been said that, when John von Neumann introduced memory into machines a new logical type of mechanism emerged. But we all know that the memory traits, so far displayed in cybernetic machines, cannot even remotely compare with the type of memory that the neurons of the animal or human brain produce.

The question is: would it be possible to improve memory in machines to such a degree that it would be practically indistinguishable from the memory capacities of a living brain in the higher species of animals? This author believes that the answer is in the affirmative but it cannot be done on the basis of mathematical theories based on classic two-valued logic. Because the universe itself as the producer of life has an ontological structure infinitely richer than anything that can be mapped by operations of classic logic.

Let us go back for a moment to the biologist who works according to the principles of the homunculus theory. His life is easier than that of the cyberneticist. If the latter wants to design biological computers, intending to imitate the activities of the universe in his machine, he must know the multi-negational code the universe uses when it is about to produce Life. But not so the orthodox biologist. In his case only the amino-acids, protein molecules and other chemical entities he works with have, so to speak, to 'know' multi-negational logic. Because they do their own engineering. He only observes and registers it. The biologist would, of course, understand better what is going on in plants and animals if he also had some knowledge of this type of logic but it is not absolutely necessary, because he can be experimentally very successful without really knowing what happens in his retort. But with the methods of orthodox biology he will never be able to give a satisfactory answer to the philosophical question: what is Life in contrast to Death?

Permit me to illustrate the limitations of traditional experimentally orientated biology with a peculiar property of biological system that has recently provoked widespread interest. I am referring to the surgical transplant organs from one living organism to another. So far medicine has not been very successful in this respect, since living systems tend to reject foreign tissue. It can be safely said that this would never be the case in a universe in which inanimate matter and living matter belonged to the same elementary contexture. But such a rejecting action will be inevitable in a poly-contextural universe. It is, of course, possible, and medicine is already working along this line, to reduce the rejective power of an organism by appropriate chemical treatment. And medicine may finally succeed in a more or less empirical method to reduce the rejective capacities of a given organism to such a degree that foreign organs may be transplanted for the normal lifetime of a patient. But that does by no means imply that the character of rejection is understood. It cannot be understood as long as our theoretical reasoning is exclusively guided by two-valued logic. In two-valued logic both values, so to speak, accept the contexturality within which they are active an which they represent alternatively. But as soon as we proceed to a multi-negational system with an indefinite number of values we become aware of a significant structural phenomenon. All values in such system can be divided into two basic categories, namely of either acceptance or rejection values. Let us say: we have a closed contexturality governed by two values, then both values will accept the specific alternatives governing the conditions of the contexturality to which they belong. However, if a third value is introduced in the confines of the aforementioned contexture it will produce a structural phenomenon which we interpret in logic as an antinomy or a paradox and which will appear within living tissue as a rejection function. Two different living persons are logically speaking compound contexturalities which are mutually rejective.

One final remark should be made with regard to the number of contexturalities which are embodied in the structure of our universe. The classic theory of reality assumes – as we pointed out above – that the world we live in is mono-contextural. Which means that all rational concepts and categories which we develop in our efforts to understand our environment belong to a simple system of two-valued logic which refers, if applied with unrestricted generality, to the ultimate background of all individual existence, namely to Being-in-general as contrasted with Nihility or Nothingness.

In contrast to it the theory of multi-negational logic maintains that every individual datum or property of our universe plays the role of an intersection point of a theoretically unlimited number of separate two-valued systems of logic or – what is the same – of elementary contextures. The consequence is that wherever we logically connect any two data of our experience we shall discover that the relation between the two is governed by the laws of classic logic. This leads us easily to the erroneous idea that the universe as a totality can be conceived as a two-valued structure. And we are not shaken in this belief, even if we observe that whenever we can establish a two-valued relation between two data of our experience there is always a third datum which is excluded from the rational contexture in which the aforementioned relation is embedded. But instead of admitting that the structure of the universe is defined by multi-negational logic, we prefer to say that the eternally excluded Third is the index of the fact that our universe has a rational as well as an irrational component. And anything which does not fit into our solitary system of classic logic must be an irrational factor well beyond the limits of our traditional system of rationality which is and remains unique and single.

This is an tradition which this paper emphatically contradicts. We assert instead that any datum of experience which is excluded from a given two-valued system connecting logically two other data of experience belongs to another equally two-valued system which operates with sufficient independence from the first in order to make it distinguishable and relatively autonomous. But relative to such a second system of two-valuedness which repeats in a different contexturality the logical feature of the first there will be again a least one datum of experience which will be excluded from it as well as from the logical alternatives of the first. This leads to the stipulation of a third two-valued contexture and so on. Thus a trans-classic logic is basically nothing also but a theory of the interconnection of all single two-valued Systems which are required to find a contexture for any observable datum of the universe. In this very contexture our datum will be connected with some other datum.

Let us assume we have the data *a* and *b* connected by means of a two-valued logic within a contexturality which we shall call Alpha. And a third datum *c* shall be excluded from Alpha. Then there will be a second contexturality Beta which connects *a* and *c* in two-valued terms but now excludes *b*. Further there will also be a third contexture Gamma which in its turn will exclude *a*. It follows that wherever we look at reality in every single instance it offers us a two-valued face which leads us to believe that the total rational structure of the universe is two-valued and that we do not need a trans-classis many-valued, resp. many-negational logic.

The traditional classic thinker concedes that there is always something excluded from his rational world concept. But he interprets the continuous emergence of an exiled Third as the influx of a supra-natural Beyond which infuses this otherwise orderly mono-contextural cosmos with an element of irrationality. It is no wonder that the Greek thinkers – who conceived this two-valued and mono-contextural scientific world concept to which we still adhere – were deeply disturbed by the discovery of the irrational numbers. Their instinct told them that the two concepts of 'irrational' and ´number´ did not fit together.

What the defender of the classic position is not aware of is the fact that it cannot be the same two-valuedness which he encounters at different ontologic locations of the universe. He is only right insofar as, wherever we isolate a objectivity devoid of all subjective finite sector of the universe as an objectivity components and consider such sector as a part separated from the totality of Being, it will always show us a two-valued and never a many-valued face. Absolute objectivity and two-valuedness are practically synonymous terms.

We shall add a final remark concerning the transition from the foregoing rather philosophical analysis to the technical question of how to develop a multi-negational logic which will give added precision to the theory of poly-contexturality. It is one of the most significant features of a trans-classic logic that it makes it almost impossible to maintain a strict division between natural number and logic concept. The reason is rather trivial. In classic logic we deal only with two values; one of them is designative, the other is non-designative. Thus only one value points to Reality and the role of the second exhausts itself in an auxiliary function. We simply need the second value to manipulate the designative value in logical operations. It follows that only one value represents, ontologically speaking, a number. But if only one number is available in terms of values, very little can be said about the connection of logic with natural numbers. An arithmetic with only one single natural number available will not carry us very far. It is highly significant that the connection between the arithmetical process of counting and logical structure is only made in a rather remote and rather problematic area of classic logic, namely in the so-called extended calculus of predicates. On the other hand if an multi-negational logic is introduced the number of values steadily increases and since a system with – let us say – 7 values shows remarkable differences from one of 20 values we can associate natural numbers with logical properties in a way which is not possible on the basis or classic two-valued logic. It is an association which remotely resembles the ancient Pythagorean ontology of numbers. And let us not forget the Pythagoreans developed their theory before Plato and Aristotle conceived the idea of a two-valued logic. Thus the theory of natural numbers becomes related to the poly-contextural concept of Life.

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Gotthard Günther [*]

Negation and Contexture

To begin with we shall have to distinguish between categorial context and universal contexture. Everybody is familiar, from the normal use of conventional language, with the idea of a context. We refer, for instance, to human beings within such different contexts as are denoted by law, by biology, by politics or by history. Within each of these contexts we assign to a person different properties. Within the context of (criminal) law a person may be guilty or not guilty. Within the context of biology we may consider a person healthy or sick, and within the context of politics an individual may be considered conservative or progressive. All these cases have one thing in common: wherever we perform a predication – as e.g. in the proposition: "this person is guilty"– we assign to the object of the predication not only a predicate but also a context within which the predicate is relevant, or not relevant. We are not permitted to ignore this relation between predicate and context. And it makes no sense to say that a sin is triangular or may be octagonal. In other words, the Tertium Non Datur (TND) which decrees that a given datum of experience must either have the property *a* or *non-a* (exclusively) normally refers to a stateable context. Such contexts may be very narrow or extremely comprehensive; but their stateablity is always required in order to make Logic applicable to the empirical world. On the other hand, this world displays such a fantastic amount of contexts and demonstrates such an impenetrable incommensurability between uncountable groups of them that it was necessary from the very beginning of the history of logic to introduce a "metaphysical" postulate with regard to the disparity and incommensurablity of certain contexts. It was assumed that all contexts are ultimately capable of well ordering and forming a universal system in the sense of the Platonic pyramid of Diairesis. This led to two conclusions which are closely connected with each other. The first is that a statement like "a sin is triangular or not triangular" is meaningful in the sense of the TND and the second that we have to stipulate that the TND may be used in two ways: either with referring to a stateable context or in the sense that it is in principle impossible to indicate the context to which the alternative of position and negation may refer. The history of logic has not always clearly distinguished between the two ways of applying the TND. The context which determines the operational field of the excluded middle in the first case may be of such practically unlimited generality that it may be difficult to find a negation for it which would establish a material viewpoint outside of the proposed context. However, this practical difficulty should not be confused with the principal absence of a context. This latter case has, in the history of logic, found its most famous expression in the *coincidentia oppositorum* of Nicolaus Cusanus.

This raises the question: is the universal system of all conceivable contexts which is denoted by the index of the Platonic pyramid also a context or is it not? The answer is

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rather obvious. A system which integrates all possible contexts cannot itself be interpreted as a context because if it were a context it would have to be stateable as such and materially differ from the other contexts. But this means it would be a potential object of integration itself which precludes that it could take over the function of integrating concepts.

If we still insist on the logical meaningfulness of the idea of a total integration of all stateable contexts it must be something that – although it is governed by the TND – cannot be defined as a context with *positive* properties. We shall call such a domain without positive properties a universal contexture and want to add that it can only be interpreted as an empty dimension which may either be filled with "objects" (scil. contexts) or not.

This means that the TND is still relevant, even under circumstances where its relevancy does not belong to a stateable context. In other words: we have to distinguish between two entirely different functions of the TND which, in the history of logic, have not always been clearly separated: the TND referring to stateable (positive) contexts on one hand, and the TND referring to a universal contexture on the other. In order to illustrate the difference and also the case where the TND is not relevant at all we shall go back to our example about the predication of sin. If we say 'sin is triangular or rainy' the TND is totally inapplicable, because 'sin', 'triangle' and 'rain' belong to three different contexts. On the other hand if we say 'sin is permissable or not permissable' the TND is applicable because sin refers to a context which is positively stateable and which is meaningful for the term to be affirmed or negated. But there is a third case which may be exemplified by the proposition 'sin is triangular or not triangular'. This latter statement should never be confused with our first one that 'sin is triangular or rainy' because in this former case we have arbitrarily chosen for predication two contexts which do not form an alternative in the sense of the TND and which exclude positively other contexts. However, if we state 'sin is triangular or not triangular' our alternative does not exclude any context at all because 'not triangular' may encompass all conceivable contexts except the one to which the term triangular belongs. Thus we are permitted to say that the statement 'sin is not triangular' is in a peculiar and limited way true insofar as this negative predicate implies all possible affirmative predicates which may be assigned to the subject of predication. But if we say, that, owing to the character of implication, there is some sense in saying that such seemingly absurd statement like 'sin is not triangular' covers some hidden logical meaning, the same must also apply to the other predicate of the alternative. What is meant is this: the term triangular is only an empirical index of some hidden 'metaphysical' property. Therefore it could be re-formulated in a way that the total alternative of triangular or not triangular would be applicable to our propositional subject called 'sin'. However, it should be understood that such a re-formulation could not be produced by a finite number of steps. Ergo it can never lead to a context which can be stated in positive terms. What this postulate of re-formulation really designates is what we have called a universal contexture. In other words: an empty domain in which operations may be performed.

Thus we have described two modi of operation for the TND. First it may operate within a stateable context which can be described in positive terms of this empirical world. Second the TND may operate in such way that it encompasses all positive contexts and puts them into relation to something that is not a positive context at all. It stands to reason that in the second case no context can be given for the operation of the TND. It designates a universal contexture. The tradition has old names for the two modes of op-

eration in which the TND may be activated. In the first case where it is concerned with a positive context it applies itself to Existence. In the second case it refers to Essence. Existence has frequently been identified with the particular forms of Being and Essence with Being-in-general as the underlying substratum for all empirical contexts of Existence. Another historical form in which universal contexture has made itself felt in the history of Logic is the *coincidentia oppositorum* of Nicolaus Cusanus. It is highly significant that it is impossible to interpret the *coincidentia oppositorum* as a material context because what coincides in it is the alternative of affirmation and negation. Thus the *coincidentia* is not negateable. But a context has to be negateable in order that it can be exchanged against a different one. This leads us to the conclusion that, if the TND is applied in such a way that no concept can be given as the range of its application, then the result will always be the *coincidentia oppositorum*. At this point Logic transcends into Metaphysics. This is incontestable in the case of Nicolaus Cusanus because he expressly identifies the *coincidentia oppositorum* with God, and since Christianity is a monotheistic religion this identification implies that there is only one universal contexture.

It goes without saying that this sort of argumentation is of little use to mathematics and exact science. For in the classic tradition a universal contexture can only denote a metaphysical entity and it is not our intent to lose ourselves in metaphysical speculations. It seems we have been led astray by following the classical argument. We shall therefore retrace our steps in order to find out whether we have not overlooked something that will permit us to remain with our logical analysis in this world instead of being transported into a mystical Beyond.

We repeat: two interpretations of the TND are extant in the history of Logic. It can be either assumed that the TND operates in a definable positive context or that it is effective although it is on principle impossible to state any positive context to which it may refer. In the first case it is capable of a material interpretation, in the second case it denotes the purest expression of formality. What has been overlooked, however, is the fact that the second interpretation of the TND is ambiguous and can be understood in a twofold way. We may either assume that the exclusive alternative which the formal TND represents may be understood as an alternative between context and contexture, in other words between material content and that which does the containing. But another interpretation is also possible. The ultimate TND may not refer to a positive context because it represents an alternative between two universal contextures. It is evident that the introduction of this ambiguity is incompatible with the total of classic tradition and especially with the philosophy of Nicolaus Cusanus. If we assume that the TND is originally directed by positive contexts which follow each other in a hierarchical arrangement of ever increasing generality, then it follows that the separating power of the TND which keeps an affirmation and its total negation apart grows weaker and weaker the more general the individual contexts become till finally the point is reached where the context becomes so general that the separating power of the TND completely disappears and nothing is left but the *coincidentia oppositorum*. To put it differently: the classic tradition postulates an ultimate collapse of the TND and at the point of the collapse the Physical transcends into the Meta-physical.

However, the recent history of Logic has debunked this type of argument because it involves the idea of a completed (actual) infinity. The elimination of the actual Infinite has been one of the most convincing results of modern set theory.

But since the hypothetical collapse of the TND leads us straight into the realm of the actual Infinite it will be necessary to abandon the idea of the *coincidentia oppositorum* as regular and methodical principle of formal Logic. This does not mean, however, that we negate the statement that with the increasing generality of the contexts the power of the TND which separates affirmation and negation becomes weaker. We only note that this is not the whole story and that the classic tradition which in itself is unimpeachable acquires a small of rawness because it more or less explicitly states in its metaphysics that it *is* the whole story.

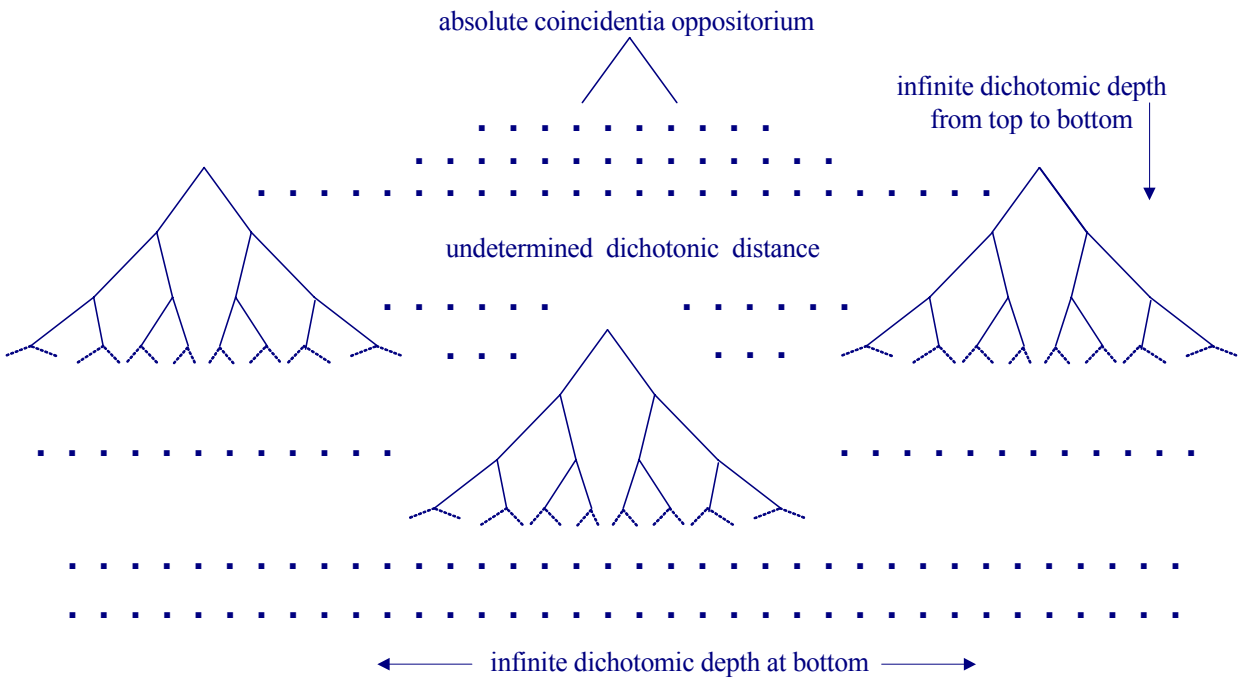
What we should consider, the whole story reads approximately as follows: While it is true that the increase of generality in the positive concepts diminishes the separating power of the TND for assertion and negation it increases at the same time its power to distinguish between context and contexture.

In order to understand what is meant by this statement we have to consider a peculiarity of the Platonic pyramid of diairesis which has occasionally been noted but never recognized in its full significance. Every logician worth his salt will readily testify to the fact that the Platonic pyramid is never properly drawn on paper if its apex is meant to represent the absolute *coincidentia oppositorum*. Because climbing up the ladder from the *differentia specifica* to the *genus proximum* we never reach any but a preliminary apex which is – no matter how many steps we have climbed and how comprehensive generalities we have attained – still an infinite number of steps removed from the absolute apex of the hypothesized *coincidentia oppositorum* of Nicolaus Cusanus.

On the other hand, we encounter an analogue situation if we descend from the *genus proximum* to the *differentia specifica*. We will never reach the bottom of the pyramid because it is supposed to represent individuals. But no matter how far we descend, we will always encounter *genera proxima* which afford us the opportunity of further dichotomies. There is no level reachable by a finite number of steps where we could say, that we have ultimately reached a basis of data that are no longer amenable to further dichotomies. The Platonic pyramid is bottomless! The indivisible individual is as much a metaphysical hypostasis as the absolute general which encompasses "everything".

It follows that a diagram of the Platonic pyramid should look as shown in Table_I. The top of the pyramid should be separated by dotted lines from its lower reaches in order to indicate the immeasurable distance between them. Their dichotomies should be disconnected in order to indicate that their common basis and ultimate connection at the bottom is unknown and unknowable. The consequence is that the Platonic pyramid as drawn in Table I contains logical incommensurabilities because it is impossible to define properly the logical relations between the three systems of dichotomies which we have drawn in the middle of Table I. It is quite impossible to say how many dichtomies they are apart. For this very reason they must be considered as indexes of different contexturalities. We have introduced the idea of the universal contexture in order to bridge the gap between the individual and the general. It is obviously not bridgeable in a world the structure of which is mono-contextural. But this mono-contexturality is exactly what our classic scientific tradition assumes. Under the circumstances it is no wonder that complains have been heard all through the history of Western civilization that Logic is not good enough to describe the richness and intricacy of empirical existence.

Table_I



The complaint is justified insofar as in the history of Logic the theory of the general has been assiduously cultivated but rarely the theory of the individual and particular. With regard to the Platonic pyramid the trend has always been up and up to higher and higher generalities, but rarely down to the bottom where materiality was located. Thus we have very few investigations about the problem how Form and Matter are related if we interpret Form as the mould of the general and Matter as the spawning ground of the individual. The Platonic diairesis is an expression of the tendency to sublimate Matter and to thin it out till the development culminates in the Aristotelian absolute Form of the Form.

It will be the task of the Logic of the future to prevent this thinning out of materiality and to retain individuality from the bottom to the top of the system of diairesis. In order to do so we have first to investigate what is meant by individuality in contraposition to generality. We begin by removing a popular misconception about the relation of 'Form and Matter' as represented by the difference between the bottom and the top of the Platonic pyramid of diairesis. In the Aristotelian system of development the beginning is represented by the totally formless *hyle*, the mere materiality. The end by an emerging form which has nothing but itself as content. We shall see there will be very little to quarrel with the Aristotelian concept of a form of the form if we interpret it as the peculiar relation of two-valuedness to its contextural envelope. So much the more, however, we have to criticize the concept of mere materiality. From it has developed the 'Weltanschauung' of vulgar or naive materialism in contrast to what is nowadays called dialectic materialism.

Nobody can really understand how Matter as conceived in the classic tradition can be the carrier of individuality. The first great system of materialism is Democritos' theory of the atoms. Matter is here an indefinite plurality of indivisible entities called "atoms". But they have as such no different individualities. What they have in common with in-

dividuality is nothing but the logical element of quantity and unity because it is senseless to talk of individuals unless there are at least two, or better many.

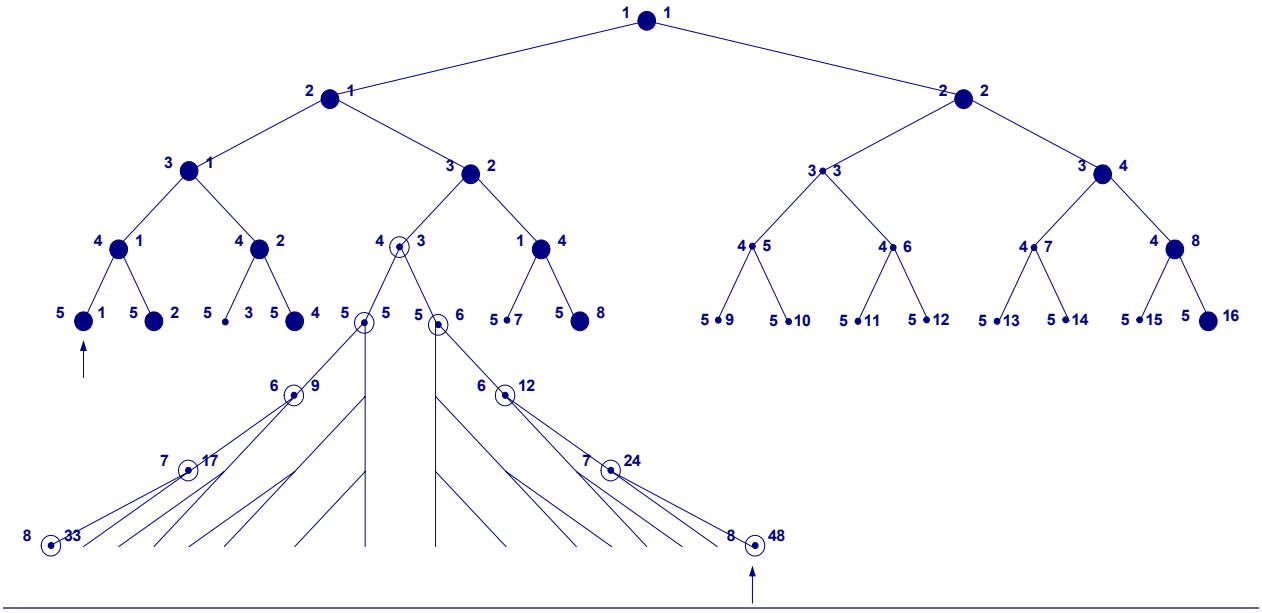
More important is a characteristic which they share with the *coincidentia oppositorum*. Since the latter is located at the top of the Platonic diairesis and the former at the bottom we notice in both cases a peculiar metabasis eis allo genos. The Platonic pyramid is nothing but a system of dichotomic relations where the apex as well as the basis is on principle unreachable, as we should never forget. But Democritos' atoms are objects and not relations and the coincicentia oppositorum as the dissolution of all differences also signifies the absence of all relation. In other words: the *coincidentia* as well as the atoms are mythological projections of basic structural properties which the Platonic diairesis displays. The properties we are referring to are: unity, plurality, symmetrical and nonsymmetrical relation.

In the classic tradition the striving for unity dominates at the expense of plurality and individuality. This theoretical trend is accompanied by heavy value accents of ethics which point out that the top of the pyramid is "better" than the bottom. It followed that the problem of the many-foldness of individuality was more and more neglected. The further science advanced the more transparent it became on account of the increasing simplicity of its basic concepts. An anecdote (perhaps apocryphal) ascribed to Einstein illustrates what we mean. This famous scientist was once asked why he had developed the Theory of Relativity. According to the story he answered: Because I found the ideas of Newton too complicated.

The trend toward simplification, however, has nowadays reached a point where very little more can be done in this direction. Moreover in recent time a host of new problems has emerged which demand for their treatment exactly the opposite, namely an increase in logical structure and a growing complexity of relationships. In other words: the guiding motive is not at the top but of the bottom of the pyramid. It is the bottom of the pyramid where the problem of the universal contexture and the idea of poly-contexturality emerges. The Platonic diairesis represents a mono-contextural system by gradually wiping out all multiplicity. This has an appearance of justification insofar as all dichotomic relations at the bottom are undistinguishable and if we replace them with Democritos' "atoms" the same has to be said about them. It is only a multiplicity of what is always the same. The atoms – or whatever we may call these ontological fix-points – are no individualities because they are no systems with an internal organisation. But they may serve as focal points from which individualities come forward.

On account of this origin the first that must be said about universal contextures is that they form a hierarchy with elementary contextures at the bottom and compound contextures arising above them in ever increasing complexity of their compound structure. The elementary contexturalities have something in common with the Democritic "atoms". They are totally indistinguishable from each other and differ only by number. But there is something else which they have not in common with the said atoms: they are systems of two-valuedness and the atom, of course, is a one-valued entity. Insofar as they have, by dint of their two-valuedness a diairetic property and on account of their unity a similarity with the atoms, they bridge the antinomy that, wherever we establish our bottom of the pyramid, we find only diairetic fissures although we are forced to think if we would only penetrate deeper, we could at last encounter ultimate entities which are units. The universal contexture is a manifestation of this dialectical relation.

Table_II



The process of gradually shaping individualities out of mere separate entities begins when a universal contexture joins other contextures in such a way that the result is what we shall call a compound contexture. A compound contexture does not originate if we just gather at our stipulated bottom of the pyramid a smaller or larger amount of elementary contextures. It is required that a compound contexture "closes" at least a single diairesis which holds between two elementary contextures. A compound contexture, even in its most elementary form, extends at least over three diairetic levels of the Platonic pyramid. In order to understand what is meant by that last statement we introduce Table_II in which the starting points of the two-valued dichotomies have been made identifiable by two numbers, one ahead and one behind the point of the departure of the diairesis. At some exceptional points the bifurcations have been made to stand out by separating the two numbers by big blackblobs the meaning of which will be explained later. The top of the pyramid is denoted by 1•1 and the basis by 5•1, 5•2, 5.3, 5•4, 5.5. 5.6, 5.7, 5•8, 5.9, 5.10, 5.11, 5.12, 5.13, 5.14, 5.15 and 5•16.

After what we have said before it should be understood now that the sequence of numbers, enumerated at the end of the last paragraph may be interpreted in two ways. If we assume that this is the absolute bottom of the pyramid and no further dichotomies are possible, then our numbers – no matter whether they are separated by blob or not – play the part of entities which are indivisible and which may be interpreted as the ultimate building-blocks of Matter... whatever that may be. On the other hand, if we assume that the pyramid is supposed to extend further down then each pair of numbers represents a two-valued system and as such an elementary contexture. It follows that terms like indivisible unit or ultimate object on the one hand, or contexture and compound contexture on the other hand are entirely relative. What may be considered an indivisible unit on one level of the pyramid may be a contexture on the next provided apex and bottom of the pyramid are shifted. But since we interpret a contexture as a closed system with an infinite range of two-valued properties we may as well interpret the data which are supposed to fill the contexture as irreducible properties of a universe based on the principle of duality or as predicates of a two-valued logic. In both cases we have abandoned the purely structural viewpoint and entered the semantic sphere.

It will be useful, for the time being at least, to stick with the consistent structural viewpoint and consider the points where dichotomies start either as indivisible units or as systems of duality. Whether we prefer one or the other interpretation depends entirely on the answer to the question: is a given starting point of a dichotomy to be considered in its relation to another starting point which is "higher" or "lower" in the Platonic pyramid. Relative to what is lower it is to be considered a contexture, relative to what is higher it must be understood as part of the duality which is content of the contexture above. (It is to be understood that we talk about such points which are connected with each other by lines of dichotomy).

After we have re-interpreted the relations between *genus proximum* and *differentia specifica* in the Platonic pyramid as relations between a system and its content – where the contents are totally ordered in the duality of position and negation – it should be clear that the Platonic pyramid has a certain affinity to many-valuedness. Such affinity is highly probable if we let us be reminded of the fact that already a three-valued system displays a specific value-duality which, however, is essentially different from the value-duality of classic Aristotelian logic. In the latter the contra-position of 'positive' and 'negative' is symmetrical as the Platonic pyramid shows. In a three-valued system two-valuedness returns as the alternative between acceptance and rejection values. This transclassic alternative has in common with the classic alternative of affirmation and negation that both are unrestrictedly governed by the TND; but whereas in the classical case the negational relation is symmetrical it is non-symmetrical in the trans-classic case.

It is always a two-valuedness which is rejected by a single value. This is enough to say that the Platonic pyramid has some relation to the theory of universal contextures for which the development of many-valued systems is necessary although this relation is not identical systematic arrangement of *genus proximum* and *differentia specifica* which a diairetic pattern displays.

In order to show the difference we have mapped the organization of a compound contexture which is carried by a five-valued system of logic onto the Platonic pyramid in Table II. It is assumed that 5•1 at the basis of the pyramid is an affirmative property, of a universe and it is connected with its negation, denoted as 5•2, in the two-valued system 4•1. This two-valued system is, in its turn, a member of a duality to which also 4•2 belongs. These two systems are related to each other within 3•1 which is, in its turn together with 3•2 connected in 2•1. We finally reach the apex of the pyramid when we ascend to 1•1 which contexturally unites 2•1 and 2•2.

Thus we have obtained four pyramids. The first with the apex 4•1 and the basis formed by 5•1 and 5•2. As apex of the next pyramid we have determined 3•1 with the intermediate stages of 4•1 and 4•2 and the basis 5•1 and 5•4. The apex of the next pyramid is located at 2•1 and runs on the left side through the dichotomies 3•1, 4•1 to 5•1. And on the right side through 3•2, 4•4, 5•8. When we finally reach the top, 1•1, we have only to add that 2•2, 3•4, 4•8 are the intermediate stages through which we reach again the bottom at 5•16.

It is now necessary to explain why there is no arbitrariness in the arrangement of the blobs which represent focal points in the structure of a compound contexturality which is supported by what we may either call (if we speak in logical terms) five values or 5 properties of the universe (if we talk in ontological terms). The basis enumerates – in terms of many-valuedness – sixteen potential values of which only five are emphasized

by blobs as belonging to the structure in question. The reason for these omissions is our demand on the TND which we discussed above, namely that the logical distance between position and negation should be infinite in order that no context stateable in positive terms could bridge the distance. We have indicated this in Table II (in the upper part) by placing the blobs only at the suitable points where the quoted demand can be satisfied. There is no difficulty about the first dichotomy counting from the left. There is nothing in between 5•1 and 5•2. Both refer to their apex 4•1. The same is to be said for the small pyramid with the apex 3•1 and the base 4•1 and 4•2. But the situation is different for the pyramid apexing in 3•1 and having its base in 5•1 and 5•4. In order that 5•1 and 5•4 should satisfy our requirement for the TND with relation to 3•1 it must be conceded that 5.3 does not belong to the structure in question. For the very same reason no blobs are attached to 5.5, 5.6, 5.7 and 4.3. The same holds for 5.9 to 5.15, also for 4.5 to 4.7 and finally for 3.3.

The distribution of the blobs in relation to the apex 1•1 represents the mapping of a compound contexture onto a finite part of the Platonic diairesis, if our compound contexture is developed as a place value system of logic with five values. The part of the values is played by 5•1, 5•2, 5•4, 5•8 and 5•16. If we arrange the values now as two-valued systems by connecting them with double-headed arrows (such arrows represent symmetrical exchange relations) we obtain ten two-valued systems which we have arranged in a significant order as follows:

5•1 ↔ 5•2
5•2 ↔ 5•4 *
5•4 ↔ 5•8 *
5•8 ↔ 5•16 *
5•1 ↔ 5•4
5•2 ↔ 5•8 *
5•4 ↔ 5•16 *
5•1 ↔ 5•8
5•2 ↔ 5•16 *
5•1 ↔ 5•16

To certain of these two-valued systems we have attached stars, to others not. We shall call those which have no stars orthodox systems and the others non-orthodox systems. The first example of an orthodox system is the mutual negation of 5•1 and 5•2, being the result of a dichotomy in 4•1. The first example of a non-orthodox system is given by the alternative of 5•2 and 5•4. Their antithesis does not stem from the same immediate apex; they refer to two different apexes which in turn form an orthodox alternative with regard to the apex 3•1. The un-orthodoxy of this relations results in the fact that already in three-valued logic we can introduce a new trans-classic two-valuedness between acceptance and rejection values. Relative to 5•1 and 5•2 the value 5•4 plays the part of a rejection value. It rejects the alternative which springs from 4•1. However, since we know from a former publication that each of the three values 5•1, 5•2 and 5•4 can assume the part of the rejection value it pays to have one more look at Table II because the Table shows graphically that all three cases of rejection have a different meaning. Only 5•4 rejects the alternative springing from the

apex 4•1. If we, however, accept 5•1 as the value of rejection then the alternative between 4•1 and 4•2 is rejected. And if 5•2 takes over the rejection function, then it is concerned with the denial of 3•1 as the source of the alternative between 5•1 and 5•4. If we move farther from the left to the right we encounter again, both categories of two-valued systems – orthodox and non-orthodox – with the only difference that with regard to the rejection the situation becomes increasingly complex.

What the upper part of Table_II illustrates is the way how a five-valued system makes its influence felt in the Platonic diairesis, extending from a properly locateable property (or predicate) which in our case is 5•1. We have indicated this orientation by placing a vertical arrow under 5•1. But, if the apex of our pyramid is supposed to remain 1•1, there is, of course, only one other point which may be considered as basic place of orientation. This is 5•16. However, in order not to interfere with our blobs in the upper part of Table_II we have chosen for the demonstration of the re-orientation of our five-valued system from 5•1 to 5•16 not the upper part of the Table but the lower pyramid which apexes in 4⊙3. One should, of course, always keep in mind that every origin of a dichotomy could be considered the apex of a Platonic pyramid which reaches down into infinity. But we have chosen 4⊙3 because it is one of the two dichotomic points on the fourth level of the pyramid with apex 1•1 which is not affected by our shift from the left to the right side of the pyramid. In the lower pyramid with the apex 4⊙3 the circles assume the functions of the blobs but their distribution is now anchored in 8⊙48 which corresponds with the previous 5•16 instead of 8⊙33 which has taken over the part of 5•1.

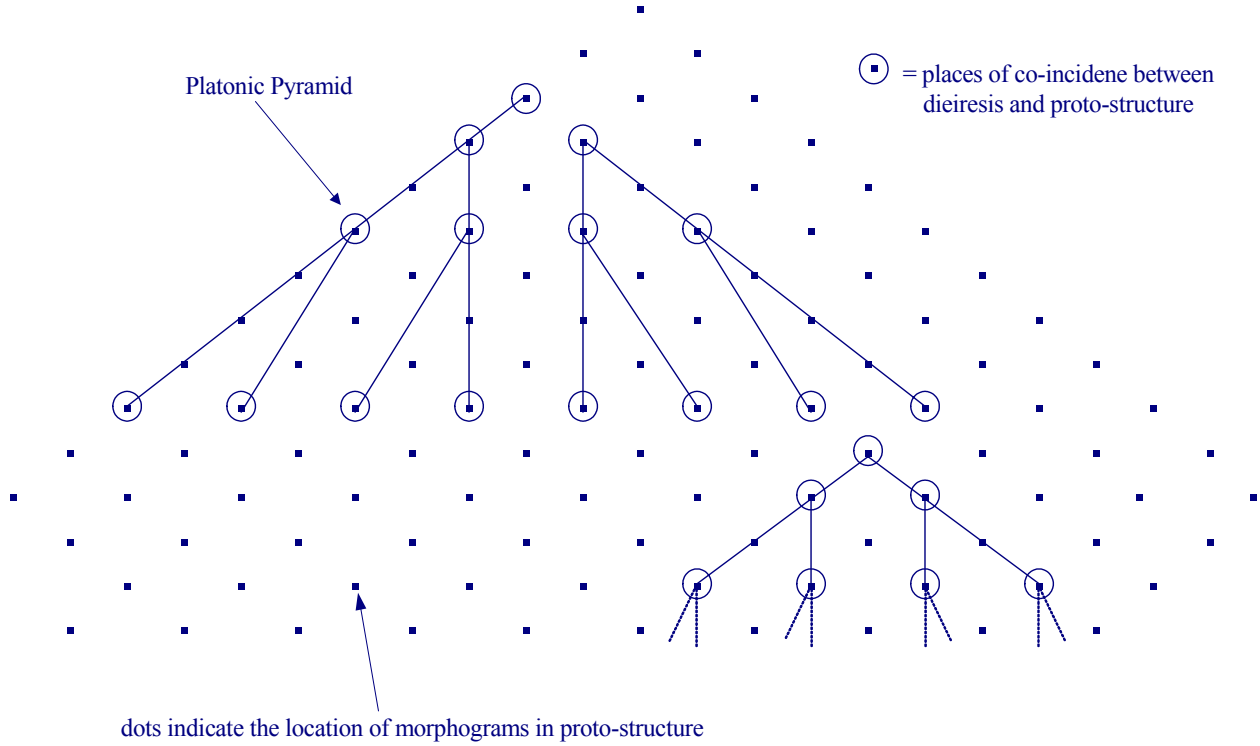
It is obvious that if we shift our five-valued system of compound contexturalities from 5•1 to 5•16 we obtain a mirror image of the original constellation. But the system of the circles orientated towards 8⊙48 also represents a mirror image of the original system anchored in 5•1. What we want to show here – although in a too elementary and incomplete form – is the difference of two mirror images on different levels of generality relative to one which is stipulated to be the original. Insofar as our universe has in a certain (although very restricted) physical sense a mirror image for every fact and event we are also aware of the fact that intelligent living systems are capable of creating so-called mental images from the same original set of data. Logic has never cleared the point how the physical image is related to the mental image. So much the more as for one single physical image there are an infinity of equivalent or not equivalent mental images.

The relation which Table_II establishes between the original five-valued system and two of its images where one is its exactly symmetrical reversal is a necessary but by no means sufficient condition to solve the problem of reflection with regard to the concept of poly-contexturality.

In order to enlarge the scope of the problem we intend to remind the reader that, what we have done in Table_II is a mapping of a compound contexture represented by a five-valued logic onto the Platonic pyramid of *genus proximum* and *differentia specifica* in three different ways. However, we may also map this pyramid in its turn onto the kenogrammatic structure as we have shown in a previous essay. Table_III offers a sampling of such mapping. The pyramid of dots represents the order of the morphograms within proto-structure and the apex of the upper Platonic diairesis is located where we write, in proto-structure, the morphogram a a a . The lower Platonic pyramid starts with the morphogram a a a a b c d e f g h . In both cases the location is arbitrary and we might

take any other dot as apex of a diairetic pyramid. The relation of the pyramids, of course, becomes more intricate if we map them onto deutero- structure and even more if we use trito-structure as background.

Table_III



This situation reveals a peculiar relation between logical values and contexture, provided we are not satisfied to confine ourselves to two values. If we do so the relation between logical value and contexture is very simple. All applications of values constitute an elementary contexture. It goes without saying that the TND is not restricted to a positively stateable context. *On the other hand, if we accept more than two values, and develop logic as a place value system of classic two-valuedness, the relation between value and contexture assumes for us, who are still too much accustomed to classical thinking habits, a very involved aspect. On the one hand, we may map many-valued systems which represent compound contexture – no matter how complex they are – onto the Platonic pyramid thus justifying the claim of the traditionalists that many-valued logic is superfluous because everything reverts ultimately to the Platonic-Aristotelian concept of logic But we may also revert the whole process and map the Platonic pyramid in an infinite variety of ways onto the kenogrammatic structure*. Considering the fact that the apex of the kenogrammatic structure can also not be reached in a finite number of steps from every mapping we do, we are forced to the conclusion that, whenever we map a many valued system onto the Platonic pyramid, this very pyramid and what is mapped onto it is includable into a kenogrammatic structure which can harbor compound contexturalities of higher complexities than the ones which have been mapped onto the pyramid. But then again, this kenogrammatic system which encom-

passes a Platonic pyramid and what has been mapped onto it can, in its turn, be mapped again onto a Platonic pyramid.

It is useless to ask what is the highest and most universal system which includes everything. Is it the system of diairesis or the kenogrammatic structure? We might as well ask what was first, the egg or the chicken. But, although this question cannot be answered, because it is erroneously posed, a different question can be answered: Is the structure of the universe we live in mono-contextural or poly-contextural? The answer must be in favor of poly-contexturality for a reason which is well known in modern logic. A monocontextural universe in the Platonic sense would represent an actual infinity in which the infinite number of steps toward the coincidentia oppositorum has been completed. A poly-contextural universe does not imply such completeness, it harbors only potential infinity.

In order to introduce a plurality of universal contextures it is not necessary to assume that in any of the contextures all performable operations have actually been performed. The only requirement which is necessary is the functioning of the TND in the way that has been described above.

There is one more objection to poly-conetxturality that we have to deal with. Since the Platonic diairesis always alternates if with contexture we try to extend the scope of our logical system and the number of alternations must always be finite – why not always stop with the diairetic arrangement arguing that only resembles the absolute state of logic which Nicolaus Cusanus envisioned in the *coindidentia oppositorum*? This question misunderstands the relation between value and contexture.

Every student knows that the higher we climb in the Platonic pyramid the more general our concepts become the emptier they are of individual detail. Just the opposite is the case with the order of the universal contextures. The more we add – starting with the single contexture of a solitary two-valued logic – the richer the detail becomes and the more individuality is developed. We have introduced the concept of the Universal contexture in order to compensate for a fundamental ommission of classic logic. There is no doubt that the coincidentia oppositorum represents the idea of a final unity into which the variegated plurality of objectivity is supposed to melt. The classical tradition had no motive to go beyond this idea because it was her ambition to develop a scientific theory of a subjectless universe. On the other hand, the religious component of this tradition raised the claim that the coincidentia oppositortum was really God himself. The upshot was that this tradition found itself in a quandary when it was called upon to distinguish between generality in the *object* and generality in the *subject*.

If we talk about generality n the subject we mean by the term 'subject', this focal point within the sphere of consciousness which in everyday language is called a soul. A logic of the future will have to draw a most rigid distinction between unity in the object and unity in the subject. But unity in the subject is something totally different from unity in the object, Where the latter is concerned we know that the more comprehensive a context of objects becomes the less individual distinction it shows till finally in the idea of Being-in-General all distinctions are obliterated. It is just the opposite with subjective unity: the more comprehensive it becomes the sharper it is delineated and the more pronounced it contrasts itself from other units of subjectivity. "Soul" in a model of flatworms almost resembles the coincidentia oppositorum. Soul in a pride of lions shows already rather sharp delineations which contexturally separate one animal from the other. But the more comprehensive and encompassing the sphere of consciousness be-

comes the stronger grows its unity and the more unsurmountable become its contextural borders. Consequently the opportunities for disharmony and strife are much greater in a human society than in a state of bees.

All these are data that have been known before empirically and they violently contradict each other within the frame of the Aristotelian system. What is required now is a logic which combines both: the charcteristics of objective unity concentrated in the so-called "It" and the features of the subjective unity centralizing themselves in the so-called "Self". This can be done by resolving the age-old distinction between matter and form into the new one between content and contexture. The distinction between matter and form remains rigid till we reach the metaphysical level of the coincidentia oppositorum. But the distinction between content and contexture is fluid from the very beginning. If we take an "individual" in the world – let us say a, molecule – it is relative to smaller units a contexture, but relative to higher units content of a contexture. This is the reason why we have to distinguish between content, individual contexture and compound contexture. Within a compound contexture the elementary contextures revert to the role of the contextural content.

Consequently the Platonic diairesis, which seemed to be eliminated creeps in again when the relation of the elementary contextures to compound contextures is analyzed. This process repeats itself again and again the more encompassing our compound contextures become. There is obviously a trend towards unity in the classical sense. But this very trend is counteracted by the fact that a compound contexture can never increase its scope unless it increases the contextural differences within its own confines. But this increase contradicts the trend towards unity in the objective sense of the *coincidentia oppositorum* about which Hegel once remarked in the preface of the Phenomenology of Mind that all cows are black in the night of the absolute. If we recognize the absolute unity in the objective sense as the total obliteration of all differences the absolute in the subjective sense would have to be defined as the total obliteration of all sameness.

It is obvious that, if we want a logic which is competent to describe a universe that is a compound of subjectivity and objectivity, we require a logic which represents essentially a compromise between these two logical trends. In other words, we have to abandon the theory of mono-contexturality and replace it by a logic of polycontextural systems.

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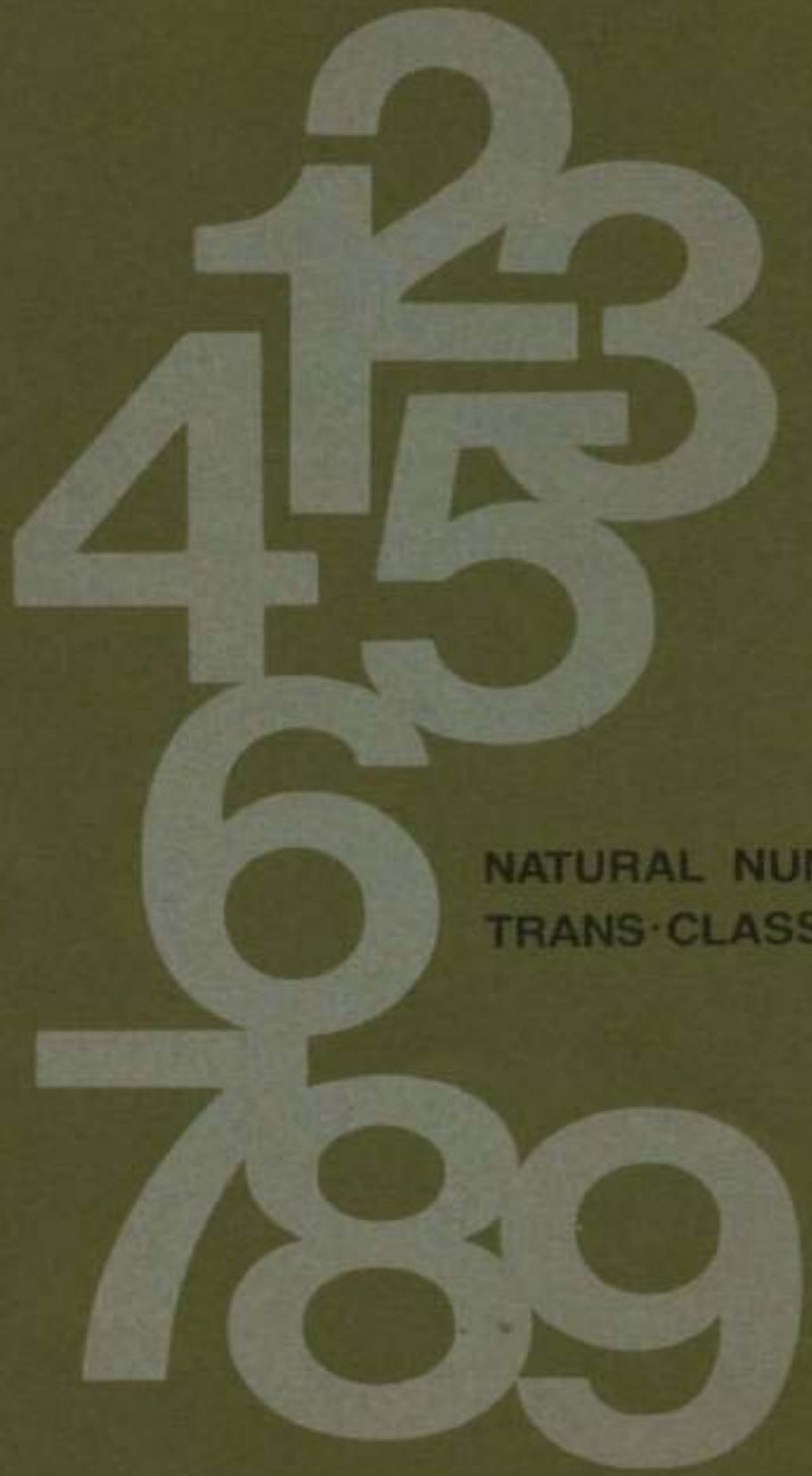

NATURAL NUMBERS IN TRANS·CLASSIC SYSTEMS

Gotthard Günther [*]

Natural Numbers in Trans-Classic Systems

PART I

Mathematico-Philosophical Prolegomena

Part II of this essay was written before Part I and offered to the Third Annual Symposium of the American Society for Cybernetics as a topic of discussion. However, owing to unforeseen circumstances, the paper was not presented at the Symposium. This turned out to be a blessing in disguise. In order to conform to the time limit for oral presentation Part II was written in a highly condensed manner and there was no opportunity to elaborate on the general epistemological aspect which served as the starting point for the intended confrontation between natural numbers and structural systems of higher complexity than our traditional logic offers. We are determined to make up for this omission in Part I because we believe that the theoretical goal of Part II will be better understood if the present author clarifies his attitude toward the basic concept of organism and its mathematical treatment in cybernetic research.

To begin with let us state that what this author has been doing for many years runs counter to the professed aims in cybernetic research. When Norbert Wiener defined cybernetics as research into "the essential unity of the set of problems centering about communication, control, and statistical mechanics, whether in the machine or living tissue," then such investigations as the present one, based on trans-classic theories of logic and ontology, run on exactly the opposite track. Theories of trans-classic logic and many-valued ontologies are introduced for the very purpose of showing *not* the "essential unity" but the *essential differences* in the concept of a machine and what Wiener called the living tissue. This is crass heresy in the High Church of Cybernetics. So far the thesis of the essential ontological difference between what is traditionally called a machine and what is called a living organism has been largely ignored and this policy of leaving out of sight the intrinsic conceptual distinction between Life and an inanimate mechanism received a strong impulse when Norbert Wiener published his book *Cybernetics*. But Wiener's work starts, as is well known, with a chapter called "Newtonian and Bergsonian Time". This chapter already contains - despite the intent of its author - elements which cast heavy doubt on the theory of the essential unity of the set of problems which involve the machine as well as the living tissue. It is highly significant that Wiener's

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* This paper is dedicated to the memory of Warren Sturgis McCulloch. The ideas expressed in the first part are to a great extent the result of a night session this author had with him toward the end of February 1969. May this paper stand as an expression of the author's deep and lasting indebtedness to a great scholar and a great man.

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confrontation of Newtonian and Bergsonian time was not seriously followed up in subsequent research, and, in fact, this author remembers that one reviewer remarked about Wiener's book that he considered the essay on Newtonian and Bergsonian time quite superfluous and that Wiener might as well have started the presentation of his case with Chapter 11 which discusses Groups and Statistical Mechanics. In this paper exactly the opposite position will be taken and we want to point out that Wiener's distinction in the concept of Time leads to two different conceptual interpretations of the phenomenon which is called living tissue or organism or more generally Life.

It is a very old insight, gained already in Greek philosophy, that the phenomenon of Life is "dialectical". Plato explains what is meant by this term. If something has dialectical character it is impossible to find for it a theory in principle capable of full formalization. It will be necessary to develop two complementary theories for it which are, in a certain way, incompatible with each other (e.g., the corpuscular and wave interpretation of Matter) but which are both necessary for an exhaustive description of the phenomenon.[1]

Present cybernetics, so far, has completely disregarded the dialectical aspects of the organism and concentrated in an entirely undialectic fashion on only one of the complementary aspects which the phenomenon of living tissue or of an organism incorporates. In the following pages we shall sketchily describe both of the two aspects accentuating their incompatibility and we shall begin with the one that has been one-sidedly favored by present day cybernetics.

An organism has, in the prevailing tradition, been described as something embodying a higher and more integrated unity than a mere classic mechanism which is a loose and partly arbitrary aggregation of anorganic parts. It has been said that an organism is dominated by the principle of superadditivity, meaning that it is essentially more than the sum of all its parts. This theory has sometimes been labeled as holism and the Oxford Dictionary defines the term as referring to a "tendency in nature to form wholes that are more than the sum of the parts by creative evolution." This provokes at once the question: If this is true for the *evolutive* time dimension of organisms (which corresponds roughly to Newtonian time), what about the complementary *emanative* time dimension?[2] The epistemological assumption of holism seems to exclude that emanative developments will also drift toward superadditivity. On the other hand, one cannot have evolution without emanation and vice versa. This is structurally impossible. At any rate, the traditional concept of organism considers organic systems as things which result from a tendency to integrative

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1 Recently Dr. Hector C. Sabelli from the Chicago Medical School has written an important paper which stresses the dialectical structure of organisms. His essay will be published in the Transactions of the VIII. International Hegel Congress, Berlin (DDR), August 23-29, 1970.

2 With regard to the structural differences between evolution and emanation see this author's monograph "Logik, Zeit, Emanation und Evolution," Publications of the Research Association of Nordrhein-Westfalen, No. 136 (Westdeutscher Verlag, Köln, 1967).

togetherness with a mutual inhesion of parts tending to obliterate the identity of the part in favor of the reinforced identity of what is called the whole.

It should be pointed out that this holistic concept of organism which stresses the aspect of unity is in a significant agreement with the tradition of classic ontology. It will be useful to remind the reader that classic ontology is essentially monism: It considers the ultimate substratum of reality as one-valued. It follows for this type of philosophy that the deeper we understand a phenomenon the more we will strive to see in it unity, continuity, homogeneity, and harmony. This is the classic scientific way into the depth dimension of Reality ... leading ultimately into the *coincidentia oppositorum* of Nicholas of Cues. The concept of universal Being which unites and reconciles the opposites is nothing if not the expression of the belief that the whole Universe represents to us the aspect of an unbroken context of objective existence. It is inevitable that in this climate of thinking the organism appears as a marvel of integration and of a prestabilized harmony. Life, for the classic thinker, is the blessed state in which the parts of the Universe "know" each other in the sense in which the Bible uses the term in Chapter IV of Genesis: "And Adam knew his wife." The *coincidentia oppositorum* is maximal superadditivity.

The one-sidedness of this epistemological attitude is revealed when we look at one of the highest triumphs of cybernetics. Thanks to an early paper of Warren McCulloch and Walter Pitts, we know that any property of an organism which we can define in finite and non-ambiguous terms can be repeated and duplicated in a nonorganic "classic" machine.[3] And let us not forget that all our nonorganic hardware has grown out of theories based on classic mathematics, two-valued logic and one-valued ontology. With this reminder let us have a look at the consequences of the McCulloch/Pitts discovery.

It has been said by philosophic pragmatism that we can only understand what we make. But we might also say, and with equal right, that if we can build a machine which displays – let us say – all possible behavioral traits of memory, then we have dispensed from a technical viewpoint with the necessity to *understand* what memory is in a living person. We know that in a living person memory establishes personal identity lasting through a given span of time; but no cyberneticist has ever seriously asserted that, if we have designed "I memory" into a piece of hardware, we have infused the latter with a sense of personal identity. It is also nonsensical to think that, with the present methods of improving the memory functions of computers, we can even approach the total role the Platonic Anamnesis plays in a living system. Cybernetics as a technical discipline does not even aim at repeating an organism itself in hardware, it only aims at repeating observable behavioral traits of organisms. It is totally indifferent to the problem of whether such behavioral traits occur in an animated biological system or in an inanimate classic mechanism – and

[3] Warren S. McCulloch and Walter Pitt, "A Logical Calculus of the Ideas Immanent in Nervous Activity," Bulletin of Mathematical Biophysics, vol. 5 (Chicago, University of Chicago Press, 1943), pp. 115-133.

whether such difference of locality may produce a different hermeneutic[4] significance for otherwise totally identical traits. The most important epistemological lesson that can be learned from the McCulloch-Pitts paper is that it defines – quite unintentionally but sharply – the boundary between cybernetics as a basic hermeneutic science which wants to *understand* the phenomenon of Life and cybernetics as a science of sophisticated mechanics which reaches for the technical know-how to imitate the results which organisms achieve within the objectively observable section of Reality. On the other hand, the process by dint of which memory contributes to the establishment of self-referential personal identity within a living person does not belong to the field of the objectively observable, which means we cannot imitate it. Being technically imitable and being on principle observable are, epistemologically speaking, synonymous terms. Thus the McCulloch-Pitts paper indirectly opens up a field of as yet untouched hermeneutic cybernetics where this novel discipline does not want to repeat and imitate living systems as a feat of hardware or even software engineering, but where we strive to *understand what is left* after the engineer has done his work.

The shortcomings of the present one-sided trend of cybernetic research make themselves felt especially when we consider the fact that cybernetic methods have made deep inroads into the Humanities, investigating, for example, problems of literature with statistical methods. It stands to reason that the cyberneticist will play his games merely on the surface of the Humanities if he ignores the hermeneutic approach of *understanding* what is already known in a merely factual sense. The traditional hermeneutic methods, however, fail because their incompatibility with the requirements of exact algorithms as they are now used in cybernetics is too great. What is urgently required is an *algorithmetization of hermeneutics.* Such algorithmetization would fall within the domain of transcendental logic. But – although cybernetics so far has completely ignored transcendental logic – the great irony is that it has willingly adopted a fateful prejudice to which the instigators of transcendental logic (Kant, Fichte, and Hegel) paid homage. It is the seemingly unshakeable prejudice that hermeneutical processes are entirely incapable of formalization.[5]

Unfortunately, we cannot raise the demand for hermeneutic *understanding* in addition to factual *knowing* without having the dialectical issue emerge again. It

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4 Hermeneutic: interpretive as different from analytic treatment of scientific data. In this context 'hermeneutic' means that a single logico-mathernatical structure, resp. the function which it determines, may be capable of different but equally valid interpretations with regard to the role it plays in a given system. Thus the process of counting of natural numbers which is discussed in Part II of this essay leads to two different hermeneutical interpretations if it designates quantities of objects in the physical universe or a mental process in the mind.

5 This boils down to the age-old prejudice that dialectics are incapable of formalization. For its refutation see Reinhold Baer, "Hegel und die Mathematik," Transactions of the II. Hegel-Congress, October 18-21, Berlin 1931 (Mohr, Tübingen, 1932), pp. 104 ss. and G. Gunther, "Das Problem einer Formalisierung der transzendental-dialektischen Logik," Hegel-Studien, Beiheft I (H. Bouvier & Co., Bonn, 1963), pp. 65-123.

must be understood that hermeneutics has no field for its interpreting activity unless a problem has been formulated in such a way that any attempt at its solution forces us to develop mutually incompatible but strictly complementary theories.

A dialectic theory of organism, based on the principle of conceptual complementarity, has not yet been developed. We have pointed out that cybernetics, up to now, has favored an entirely one-sided nondialectical concept of organism, obtaining remarkable but equally one-sided results. These results have already had a considerable impact on present society. But since their one-sidedness and concomitant social ambivalence has not yet been clearly recognized, computer theory has, sociologically speaking, proved a limited boon but to a much greater degree a calamity.

We have characterized the holistic viewpoint of organism as one where everything seems to gravitate toward a center of self-referential integrative identity with its relative reconciliation of the opposites which produces a precariously balanced superadditive unity. We shall now describe the complementary aspect of living systems which reveals itself in the intrinsic dishomology of incompatible elements straining away from each other and drifting towards dissolution of the wholeness which the other aspect shows us. Both tendencies coexist in living systems and are equally characteristic of them. Their difference is closely related to the fact that each living system has an evolutionary as well as an emanative history.

So far cybernetics has looked on living systems overwhelmingly from the viewpoint of evolution and, seen from here, the development of these systems seems – as we pointed out – to tend toward higher and higher integrated forms of unity and wholeness, implementing the principle of a "transcendental" superadditivity. On the other hand, if we look at the phenomenon Life as: a result of emanation, exactly the opposite type of properties seems to govern the development. Emanatively speaking, the development of systems of higher and higher organic complexity seems to accentuate a tendency towards internal disunity and disintegration. Seen from here the development seems to, be guided by a principle which we might call that of super-subtractivity. In the decay of a dying system more is lost than the sum of its parts. Moreover, organic systems incorporating an unusually high complexity are capable of an intensity of dissension and disharmony which cannot possibly develop in systems of lower organization, because there is in the latter not sufficient structural richness to entertain such a pitch of dissonance and discongruity as may originate in highly complex systems with intricate mediative functions which are subject to failure. The richer a structure the more it displays incompatible properties which not only resist unification, but positively favor, by the ever-increasing amplitude of their negations, the disjointive character of the system. In other words, the stronger the trend toward super-additivity, the stronger the complementary trend towards a "super-subtractivity." This second tendency is dominated by a universal structural property which does not occur explicitly in one- or two-valued systems, but makes its entrance at once when we proceed to the most elementary form of trans-classic systems which possess three values.

This author has pointed out in a former publication[6] that all logical values in a three-valued system arrange themselves in a dichotomy of acceptance and rejection values. The acceptance values, of course, enforce through their activity the holistic tendencies of the system. The rejection values, on the other hand, work in the opposite direction. Their activity tries to pull the system apart. But the rejection values are only comparatively weak symptoms of a deeper structural feature that we have christened in Part II with the name of "discontexturality". What we mean by this term is explained in Part II by the effect discontexturality exerts on one of the simplest structural phenomena we know, namely the unilinear sequence of natural numbers. We shall notice that discontexturality dissolves the conceptual unity of any given natural number. It infuses into the general concept of natural numerosity a dialectic ambiguity. This brings us into conflict with the traditional logical theory of natural numbers where a number is considered a predicate of a predicate in the extended predicate calculus of classic logic.

The logical ambiguity and amphibology of natural numbers raises an interesting issue about the future development of mathematics with regard to its application to cybernetics. How far – we must ask – are the present mathematical theories geared toward furthering the viewpoint of holism? And what should be done to make mathematics a tool for effective investigation of the phenomenon of discontexturality? One thing is certain: Our traditional mathematical theories and practical procedures are basically derived from the duumvirate of one-valued ontology and two-valued logic. It is highly significant that the theory of many-valued ontologies which is an unavoidable consequence of discontexturality is not even mentioned in the foundation theory of mathematics. The use of many-valued logic is mostly declined because – so it is argued – it leads to unresolvable logical difficulties.

It is not yet recognized that difficulties engendered by many-valuedness of formal logic are the safest indications that we have finally arrived at the point where the dialectic structure of modem science emerges. It is characteristic for the traditional monistic and strictly nondialectic tendency of science that these difficulties are merely evaluated as subjective errors of thinking and taken as a signal for retreat from established classic methods. During the last decades enormous efforts were made to remove such difficulties in the interest of a philosophic holism which aims at mapping the Universe as a system of total consistency within the contexturality of one-valued Being. On the other hand, it is also a well-known fact that *all efforts to construct a scientific theory which views our Universe as an unbroken context of one-valued objective existence have failed.* But let us say that such efforts have not failed because our subjective technique of reasoning was faulty (as is generally assumed); they have failed-even if impeccable reasoning was applied-because the Universe we live in does not present itself to us as an unbroken context of objective existence. It was not recognized that the emergence of unavoidable contradictions, antinomies and paradoxes in logic as well as in mathematics was

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6 G.Günther, "Cybernetic Ontology and Transjunctional Operations", Self-Organizing Systems 1962 (Spartan Books, Washington, D.C., 1962), pp. 313-392.

not the negative symptom of a subjective failure but a positive index that our logical and mathematical reasoning had entered a new theoretical dimension with novel laws for which the classic tradition of human rationality – although impeccable in itself – provided hardly any antecedents. Contra-classic historical antecedents beholden to this mysterious dimension were available, but they belonged within the history of the human mind into the dubious and slightly disreputable side-show where Pythagorean mystical number speculations, gnosticism, the arithmetical games of the Kabbalah and Lullianism eked out their neglected and scurrilous existence. It was Schelling who made a valiant attempt to rehabilitate this tradition in which especially the paradoxes were well at home. Schelling did not succeed – in fact, he acquired only for himself a doubtful reputation. What his opponents did not see was that one had to make a distinction between a legitimate thought and its sometimes doubtful method of application. There can be no doubt that the whole success of exact Western Science was due to the fact that, since the times of the Greeks, a most rigorous process of eliminating and discarding highly legitimate problems was going on. Only such problems were selected for investigation for which suitable means could be found to treat them in a controllable and rational manner – derived from the principles of classic logic.

Book M of Aristotle's *Metaphysics* is an excellent example of how questions were eliminated from number theory for which there could be no intelligent answer expected on the level of classic tradition. No wonder the discarded questions and problems degenerated in the course of history and were discussed in a manner which removed them farther and farther from the grasp of responsible science. But let us repeat: Their original banishment is in no way prejudicial to their seriousness, depth, and validity. One of the most important of the problems involved was the Pythagorean conception of an Arithmetica Universalis as Helmut Hasse has called it. By this term he meant the idea of a complete arithmetization of ontology all the way down to the individual object. The guiding idea of the Pythagoreans was that if any two things relate to each other in the manner of numbers, then they are themselves numbers in an ontological disguise. The idea of the Arithmetica Universalis was quickly discarded, because the scientific tradition founded by the Greeks implied that scientific reasoning was only entitled to interpret a Universe from which all traces of subjectivity had been removed. On the other hand, it was entirely impossible to deal with the problem of an Arithmetica Universalis without raising the question: What is the difference between a subjectless Universe and a Universe which harbors subjectivity?

But the difference between a subjectless Universe of straight objective contexturality and a Universe animated by subjectivity is, on the greatest scale, equivalent to the distinction between the holistic and the discontexturalistic viewpoint which we derive from the idea of organism. A modem novelist (Franz Werfel) lets one of the figures in a utopian novel answer the question: What is the shape of the Universe? The terse reply is "The whole has the shape of Man."[7] The universe Werfel's questioner referred to is undoubtedly the

7 Franz Werfel, "The Star of the Unborn" (Viking Press, New York, 1946).

Universe gifted with subjectivity of which the complex organism is a structural replica. This Universe was *not* the object of theoretical science as the Greeks conceived it and handed down to us. Their enormous instinct for abstract theory made them aware that initial scientific progress could only be achieved if the object of investigation was sufficiently simplified to satisfy very elementary and basic methods of research. This led them to *the ontological reduction from the animated Universe to the subjectless concept of Reality.* Such reduction permitted them to retain as an ultimate metaphysical perspective the holistic viewpoint by postulating the total unity of the primordial substratum, but forced them to exclude the anti-holistic viewpoint of discontexturalism, from ontology. The latter viewpoint was implied in the philosophy of Heraclitus, a philosophy that significantly exerted no lasting influence on the evolution of scientific methods.

By performing their ontological reduction, focusing on holism, but discarding all motive of discontexturality in their metaphysics, the Greeks avoided the difficult confrontation between formal logic and mathematics on one side and the theory of dialectics on the other. It should be added that we moderns have followed faithfully this Greek tradition up to the present day. On the side of philosophy a first attempt to defect from the Greek tradition was made in Kant's *Critique of Pure Reason,* especially in his doctrine of Transcendental Dialectics. Fichte, Hegel, and Schelling followed in his path, but mathematics and empirical sciences have up to now avoided the issue completely. Their methodical ideal is still the radical objectivization of their subject-matter.

However, since the advent of cybernetics it has become impossible to dodge the problem of subjectivity any longer. And since cybernetics cannot progress without the proper mathematical tools, mathematical foundation theory is confronted with the demand to forge new instruments capable of dealing with the peculiar properties of self-referential systems. This calls for a revision of the traditional logical and ontological basis of mathematics. The mathematics of our day still starts from the assumption of neo-Platonic henism and its vulgar derivative, called monism. But henism leads inevitably to holism. It follows that our present mathematical reasoning is not yet geared to the idea of a Universe which reveals itself to us only as a dialectic union of holism and discontexturalism. It has been said before that such dialectic union demands a specific logic and concomitant arithmetic to deal with the contradictory, but also complementary, aspects which the appearance of Life in a physical Universe displays.

On the one hand, living systems must be considered as contexts of objectivity infused with a subjectivity that is progressively objectivizable. On the other hand, living systems must also be regarded as contexts of subjectivity which have been generated by a gradual subjectivization of the natural objects. The difficulty is that both processes are not exactly inverse to each other. A subtle asymmetry is involved. Thus the confluence of the objectivization of the subject and the subjectivization of the object produces intricate structures which are nowadays not even remotely understood because we have not yet developed any mathematical tools for a progressive formalization of dialectic logic. These tools are so far missing because we do not yet possess a dialectic theory of natural numbers.

A first attempt to dialectically analyze the concept of natural numbers was made by Plato. But since it ran counter to the general trend of Greek science the problem was practically forgotten till modem times when mathematics was confronted with the problem of many-valued logic. But even now very little progress has been made because there is no general agreement about what many-valued logic really is. In fact, two concepts of many-valued logic exist side by side: In 1921 Emil L. Post introduced a triadic classification of "positive", "negative", and "mixed" for the traditional functions of two-valued logic. In other words: Any additional values are here considered as "mixtures" of positive and negative. This means that the original ontological conception of two-valuedness is retained and any additional values are only second-order derivatives from the two classical values. But there exists also (without giving up the theory of "mixed" values) the possibility of interpreting any additional values which are added to positive and negative as *different in kind* and not derived from a mingling of positive and negative. In the first case a theory of many-valuedness results that is symmetrical but not completely formalizable. *Any radical formalization of it makes the original two-valuedness reappear,* The second interpretation of many-valuedness leads to an asymmetrical system where radical formalization does not mean retrogression to two-valuedness. If we introduce Post's concept of many-valuedness, there is no need for a revision of the classic ontological foundation of mathematics; no problem of dialectics is involved. On the other hand, if we confront mathematics with the second interpretation of many-valuedness, we obtain an additional richness of ontologically interpretable structure which requires a new mapping; it is then reasonable to ask whether the theory of real numbers could be derived by an analog method from rational numbers and so on down the hierarchy of numerical types to the natural numbers at the bottom. What is still missing is the postulated connection between the rational and the real numbers. If this connection were found we would be entitled to say that all higher types of numbers are nothing else but very sophisticated aspects of natural numbers and their properties – properties derived from classic systems as well as from trans-classic ones.

As a reason for the difficulty of finding the missing link, the argument is usually given that, if we start discussing real numbers, we get involved with the problem of infinity. For this very reason it seems impossible to interpret the calculus of real numbers as a calculus with any *finite* sets of rational numbers. However, the argument – although correct as far as it goes – does not satisfy a logician who takes trans-classic systems into consideration, because so far *mathematical foundation theory has made no distinction between concepts of inifinity, relating to a subjectless Universe and those relating to a universe endowed with the property of self-reference.* What is infinite *per se* in the first Universe may be treated as finite in the second. Seen from here, the otherwise divergent approaches to the theory of real numbers of Weierstrass and Cantor on one side and Dedekind on the other seem to be almost identical. In both approaches the set used for the definition of a real number must be infinite. But if one reads the relevant papers of Cantor as well as Dedekind's "Stetigkeit und

irrationale Zahlen,"[8] one cannot escape the impression that these famous mathematicians are only concerned with the behavior of numbers in a subjectless universe.

Part II tries to show how natural numbers behave in a Universe that embodies self-reference. However, there is a fundamental distinction between the idea of a self-referential universe as it was conceived in a former mythical philosophy of nature, as, for example, in Fechner's "Weltseele," or, if we want to go back to the most ancient Scriptures of mankind, as in the saying of the Chāndogya Upanishad "Self is all this," and the idea of self-referentiality as we conceive it here. In the mystical philosophy of nature it was assumed that the universe was self-referential as a whole – because no distinction was made between auto-referentiality and self-referentiality. This led, if a living system was considered to be a (complete or incomplete) structural replica of the Universe, automatically to the holistic interpretation of an organism. In contra-distinction to this tradition we maintain, however, that, although the universe as a whole may be considered to be auto-referential, it can have the property of self-reference only in preferred ontological locations of suitably high complexity of structure. It is this distinction that has led us to the dialectical antithesis of holism and discontexturalism with regard to the interpretation of living systems. In the evolutive striving towards Life, mechanisms developed more and more holistic aspects and followed a principle of superadditivity. But all Life is condenmed to decay and Death, which shows up in the theory of structures as the property of discontexturality and a tendency toward super-subtractivity.

In the following Part II we have made a first tentative effort to lay a foundation for a theory of mathematics for living systems. However, owing to the external circumstances which dictated the composition of Part II, we have confined ourselves to the utilization of the discontextural and not the super-subtractive motive in discussing the behavior of natural numbers in trans-classic systems.

8 See also Richard Dedekind, "Was sind und was sollen die Zahlen?" (Vieweg & Sohn, Braunschweig, 1918, first edition 1886). 17he other paper (same publisher) appeared in 1872.

PART II

The Mapping of Natural Numbers onto Kenogrammatic Structures

In Lewis Carroll's profound fairy tale *Through the Looking Glass* there is a scene where Tweedledum and Tweedledee have led Alice to the Red King who is sleeping in the woods:

> " 'He´s dreaming now,' said Tweedledee: 'and what do you think he is dreaming about?'
>
> "Alice said, 'Nobody can guess that.'
>
> "'Why about you!', Tweedledee exclaimed, clapping his hands triumphantly. 'And if he left off dreaming about you, where do you suppose you´d be ?
>
> " 'Where I am now, of course,' said Alice.
>
> " 'Not you!', Tweedledee retorted contemptuously. 'You´d be nowhere. Why, You´re only a sort of thing in his dream!'
>
> " 'If that there king was to wake,' added Tweedledum, 'you´d go out-bangjust like a candle!'
>
> " 'I shouldn´t!', Alice exclaimed indignantly. 'Besides, if I´m only a sort of thing in his dream, what are you, I should like to know?'
>
> "'Ditto,' said Tweedledum.
>
> " 'Ditto, ditto!', cried Tweedledee.
>
> "He shouted this so loud that Alice couldn´t help saying 'Hush! You´ll be waking him, I´m afraid, if you make so much noise.'
>
> "´Well, it´s no use *your* talking about waking him,' said Tweedledum, 'when you´re only one of the things in his dream. You know very well you´re not real.'"

Lewis Carroll is talking about one of the most ancient, most fundamental and most unsolved problems of Philosophy. It is the problem of the relation between Reality as a Prototype and its reappearance in the Image. The Image is an iteration of the Prototype; it repeats or maps the contexturality of the Prototype and, as a mere repetition, it is structurally identical with what it has mapped.

What distinguishes the Image from the Prototype and establishes logically their identities is their mutual discontexturality. No matter how loud the discourse between Alice and the Tweedle brothers may get, it will not wake the Red King, because the existence or mode of Reality of Alice and the Twins is discontextural with the physical body of the King who is – or seems at least – to be lying in front of them in the grass. The chain of cause and effect as well as that of logical reason and consequence always end within the limits of a given contexturality.

We shall equate the specific context of existence to which the body of the King belongs with an ontological locus and say that the body of the Red King occupies a different ontological locus from the one in which Alice – who has stepped through the looking glass – exists. What Tweedledum tries to explain to Alice is that the events occurring within a given contexturality will not carry over into a different one.

However, if neither the chain of cause and effect nor the linkage between reason and consequence will carry over from one ontological locus to another which belongs to a different contexturality, then any counting process will also be confined to the contextural limits within which it originates. In other words: for a trans-classic logic which derives from a plurality of ontologies and ontological loci there is not just one sequence of natural numbers. There are many such sequences, all obeying the so-called Peano axioms but separated from each other by their mutual discontexturality.

Our traditional scientific methods use a logic that is based on the contraposition of two ontological loci which refer to the metaphysical designations of Substance or Being on one side and Negativity or Nothingness on the other. Their discontexturality is obvious. No chain of events, started within the ontological locus of Being will carry over into and continue within Nothingness. The same goes, of course, for the process of counting. It is trivial to say that we shall stop counting if there is nothing to count. The point we intend to make here is that our original process of counting will also stop, if we switch over from one ontological locus to another and discover that there is something to count. This will always be the case, if the other ontological locus belongs to a different contextural domain which may combine two or more ontological loci. Such a crossover into a different contexturality would force us to start another sequence of natural numbers.

Since classic logic has at its disposal for objective descriptions of Reality only a single ontological locus, there will be no question of different contexturalities. Everything belongs to the same ontological context or it is just nothing. Being is one-valued – it just is. That is all there is to it. That our classic logic is two-valued is entirely due to the fact that it represents a mapping process. You may have something that is one-valued, but you cannot map something with one value. But it should not be forgotten that the second value plays only a supporting and assisting role. Ontologically speaking it designates nothing. One-valued Being is auto-referential. It refers to nothing outside its own contexturality. Simply because there is none. Auto-reference is reference between different elements belonging to the same ontological locus. It follows that a scientific world concept coupled with a two-valued mapping process is forced to exclude from scientific inquiry all such phenomena as do not belong to the contexturality of one-valued Being. On the other hand, it is evident that the very process of thought is hetero-referential. Thought refers to and maps something that is not Thought and that does not belong to Thought contexturality. The belief that Thought-context and objective Being are contexturally identical is Magic. The magic formula of a sorcerer would have a physical effect only if formula and object belonged to the same ontological locus. But a formula is only a hetero-referential image of something that is and it partakes qua image in a different contexturality.

Unfortunately, we possess hetero-referentiality where the reference carries from one locus to another merely as a "subjective" vehicle for scientific inquiry. This vehicle is our traditional two-valued logic. We are not yet in possession of an ontology supporting a concept of Being where "Being" would not only refer to something that just is but to one that, at the same time, has an image, because it is capable of sustaining "objective" processes of hetero-reference. But if we

talk about entities capable of hetero-referential actions we refer in fact to living systems and imply a trans-classic concept of Existence which can accommodate discontexturality. However, the integration of discontextural elements that characterizes living bodies does not exhaust itself in the simple distinction between Prototype and its hetero-referential Image (including the image-making process). The phenomenon fills more than two ontological loci. In fact, the number of ontological loci involved in the existence and the activities of an organism is practically inexhaustible, and we can only point out that Time, e.g., requires its own ontological loci and so does Subjective Self-reference and also the juxtaposition of the I as the subjective ego and the Thou as its objective counterpart. We leave the question open as to how many ontological loci are required to establish all these separate contexturalities. That a contexturality is identical with a single ontological locus is true only for special cases of considerable simplicity. It is our contention that organisms encompass an indefinite number of ontological loci, and concomitant with this, different contexturalities. If we combine this assertion with the insight that a system of natural numbers is always confined to the specific contexturality within which it originates, then we will be forced to the conclusion that we need a special theory of natural numbers for the phenomenon of living matter. The issue does not exist in traditional two-valued mathematics because the latter has only one ontological theme, namely that of auto-referential Being. And the auto-referential sequence of natural numbers is defined by the well-known axioms of Peano. The key axiom is: no two numbers have the same successor. Wherever this axiom is valid we shall henceforce speak of a Peano sequence.

Since the structural properties of hetero- and self-reference can only be described in a trans-classic system of logic it will be necessary for a mathematical theory of living systems to map the natural numbers onto the basic logical elements of trans-classic logic. These elements, however, are not the values but the kenograms, i.e., empty places which merely indicate structure and which may or may not be occupied by values. Either a single or a collection of kenograms may represent an ontological locus. If an ontological locus coincides with a single kenogram we shall say that the resulting system has auto-referential contexturality. No two ontological loci may have the same number of kenograms. The supply of kenograms is infinite and, for the purpose of mapping numbers onto them, they may be composed in sequences of any required length. This affords us two choices of composing kenogrammatic sequences: we may either repeat a single kenogram until the predetermined length of a sequence is reached, or we may fill the sequence with kenograms of different shapes. (We shall use as symbols for kenograms the small letters of the Latin alphabet.) Kenogrammatic sequences of constantly increasing length, added vertically to each other, and those of equal length, joined horizontally, form what shall be called a kenogrammatic structure which can appear in three degrees of differentiation. We shall call them

proto-structure
deutero-structure
trito-structure

In proto-structure (see Table_1) only one kenogram is iteratable and the placing of the symbols is irrelevant. In deutero-structure any symbol is repeatable,

provided there is room for repetition; the placing still remains irrelevant. What distinguishes trito-structure is that now the placing of symbols becomes important.

Table_1

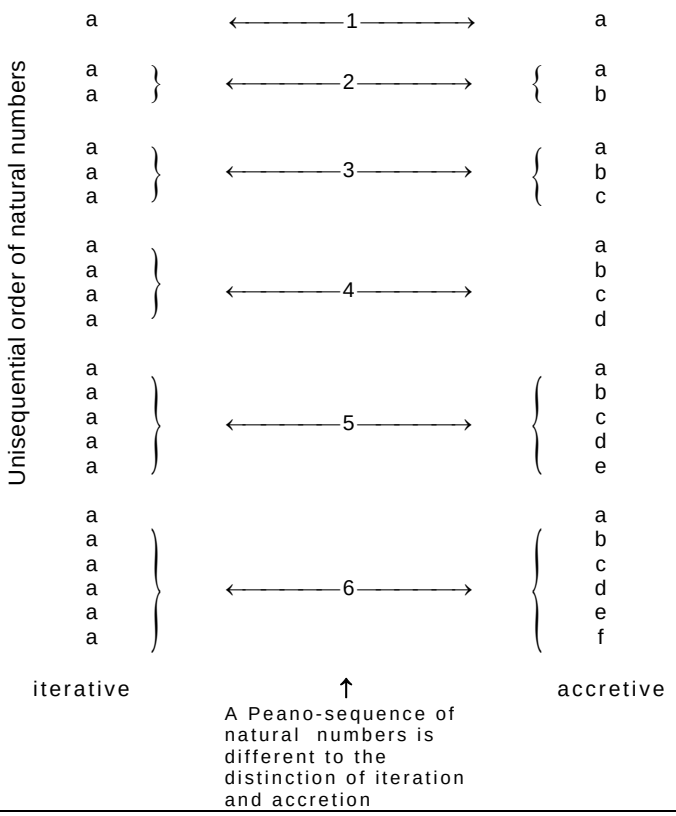
Kenogrammatic Structure

Proto-	Deutero-	Trito-Structure
a	a	a
a a a b	a a a b	a a a b **classic**
a a a a b b a b c	a a a a b b a b c	a a a a a a a b b b a b a b c
a a a a a b b b a b c c a b c d	a a a a a a b a b b a b b c c a b b c d	a a a a a a a a a a a a a a a a a a a a b b b b b b b b b a a b b b a a a b b b c c c c a b a b c a b c a b c a b c d
a a a a a a b b b b a b c c c a b c d d a b c d e	a a a a a a a a b a b b b b a b b c b c c a b b c c d d a b b c c d e	a a a a ..... a a a a a ..... 52 ..... b a a a a ..... c a a b b b ..... morphograms ..... d a b a b c ..... e
a a a a a a a b b b b b a b c c c c a b c d d d a b c d e e a b c d e f	a a a a a a a a a a a a b a a b b a b b b b a b b a c b b c c c c a b b b c c b d c d d a b b b c c c d d e e a b b b c c c d d e f	a a a a ..... a a a a a ..... 203 ..... b a a a a ..... c a a a a ..... morphograms ..... d a a b b b ..... e a b a b c ..... f

In order to undertake the mapping of natural numbers onto this structure we shall, for the time being, only consider the kenogrammatic sequences which are outside the vertical lines of Table_1. We notice that the ones on the extreme left side are always formed by writing the only available symbol again and again. We shall call this "increase by iteration."[9] If we turn to the right side we notice that no symbol is ever repeated; we shall call this "increase by accretion." In Table_2 we have confronted the Peano numbers with the symbol sequences originated by straight iteration and by straight accretion which constitute the boundary cases of the kenogrammatic structure. The integers in the center of the table represent the Peano numbers, and the arrows, pointing to the left and the to the right, aim at the kenogrammatic sequences with which the numbers are associated.

9 Iteration is the principle according to which David Hilbert interprets the budding-up of numerical quantity. See "Die Grundlagen der Mathematik," Hamburger Mathematische Einzelschriften, No. 5, 1928. See esp. p. 4.

Table 2

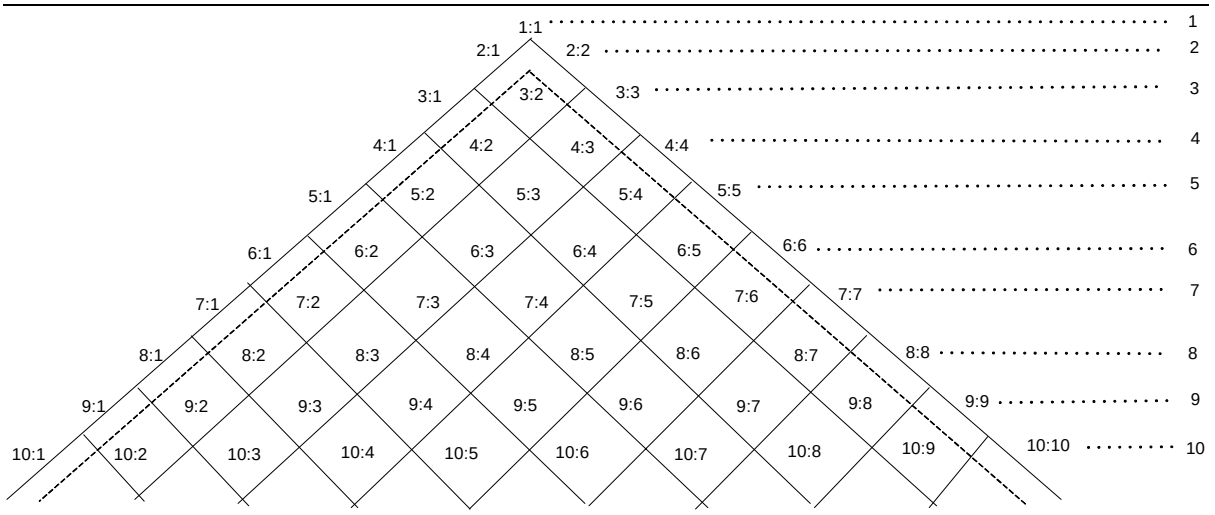


It is now possible to make the following statements: Each set, consisting of n kenogrammatic places on the left side, belongs to the same natural numbers as the set consisting of n places on the right side. If we take, for example, the two kenogrammatic sequences on the second line, then both sets are doubletons. Equally, the set consisting of three places on both sides of the third line is a triple; i.e., each set belongs to the same natural number. Thus, kenogrammatic sequences of equal length always coincide arithmetically with the integer between them ... provided they are built up by the principle of consistent iteration or accretion. There is no difference between iteration and accretion in terms of Peano numbers.

This indifference, however, disappears at once if we introduce two or even more ontological loci. It should be remembered that, although the first ontological locus requires only one kenogram, the second – to distinguish it from the first – requires two. This means that we encounter for the first time a trans-classic logical situation when we arrive at three-place sequences, because in this case we do no longer face a simple contra-position of pure iteration or pure accretion, since the sequences $\begin{matrix}a\\a\\a\end{matrix}$ and $\begin{matrix}a\\b\\c\end{matrix}$ are separated by a "mediative" sequence $\begin{matrix}a\\b\\b\end{matrix}$.

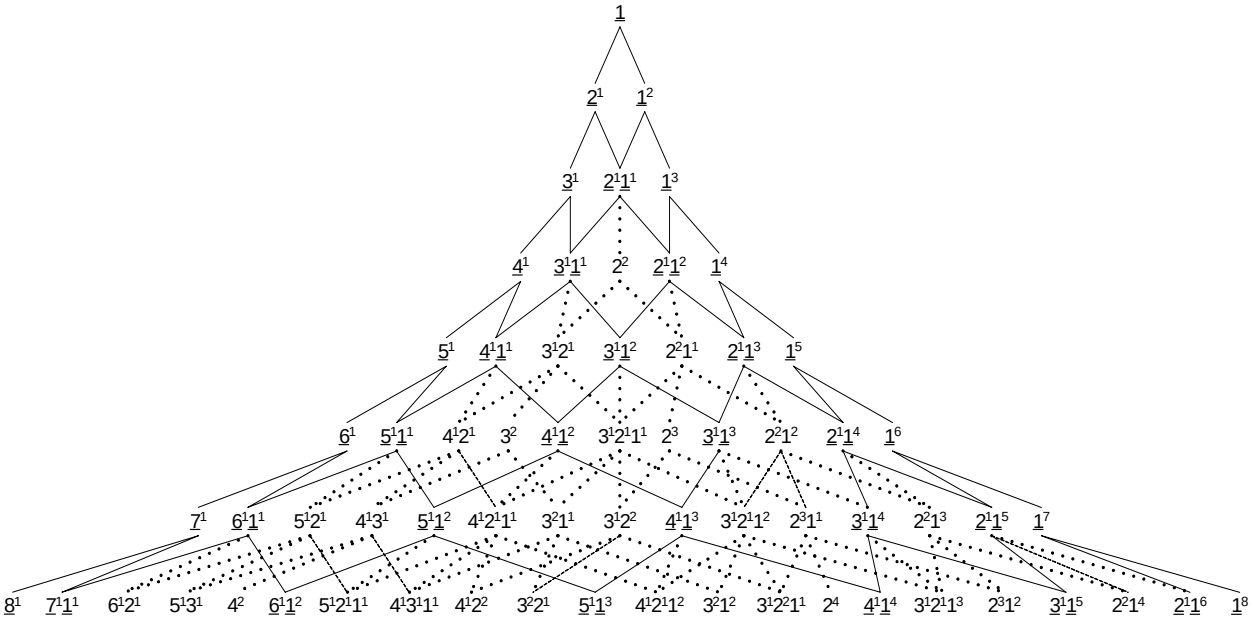
It follows that, if we introduce the concept of a plurality of ontological loci which would permit the introduction of discontexturality into the theory of logic, a corresponding system of natural numbers should be devised where we would not just proceed from a given number to its Peano successor but from a predecessor number with the specified logical property X to a successor number with – let us say – the property Y.

Table_3



In Table_3 we have given the sequential arrangement of the first ten proto-numbers with the corresponding Peano numbers on the extreme right side. Within this semi-Platonic pyramid we have separated the numbers of straight iteration and straight accretion from the "mediative" numbers by two dotted lines meeting at the top. The numeral ahead of the colon indicates the length of the kenogrammatic sequence, the second numeral gives the degree of accretion.

Table_4



The "arithmetic" resulting from proto-numbers may be considered rather trivial. But the mapping of the Peano sequence onto deutero-structure shows already less trivial features. Table_4 displays the formation pattern of deuteron-numbers if 1 is added, either iteratively or accretively to a predecessor number. Since in deutero-structure any kenogram is repeatable the simple notation of protostructure will no longer satisfy our requirements. A deutero-structural sequence and its corresponding number however will be fully characterized if

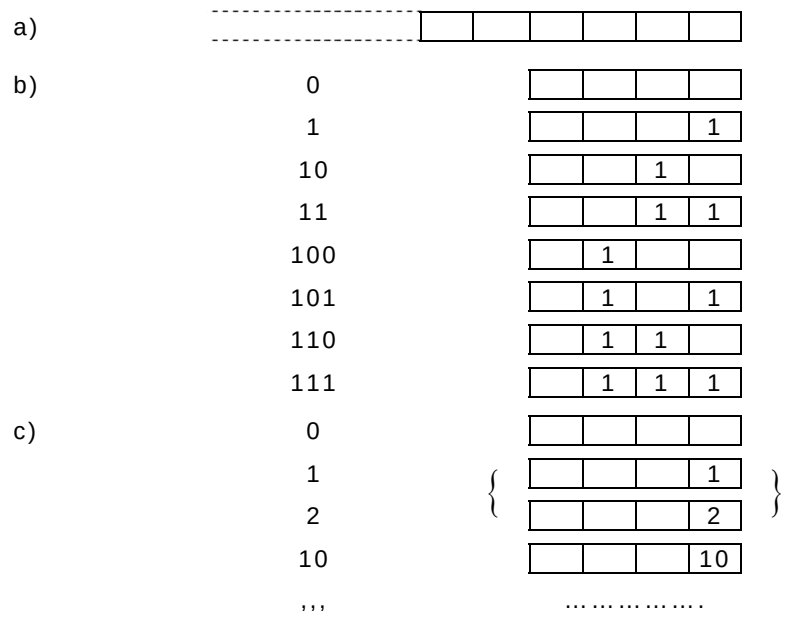
we count the number of iterations and indicate by superscript for how many kenograms a given sub-sequence of iterations occurs.

In Table_4 the lines of succession which connect deutero-numbers with each other are partly drawn in a dotted fashion. The lines fully drawn out repeat the summation sequence (+1) for proto-structure; and the dotted lines show the additional summation sequences (+1) which are produced by deutero-structure. It should be noted that a number sequence, once it has entered a dotted line, never merges again with a continuous line. This means, deutero-structure contains two distinct patterns of successorship. As in proto-structure, the numbers representing either pure iteration or pure accretion play a separate role. No numbers which belong to the succession pattern of the dotted lines issue from them. On the other hand, every mediative number is the point of origin for a specific sequence of dotted lines. However, one should not interpret the deutero-numbers of straight iteration and straight accretion and all the other numbers in deutero-structure connected with them by continuous lines as proto-numbers which form some sort of conglomerate with bona fide deutero-numbers turning up along the dotted lines. All deutero-numbers, no matter what their characteristics, are only *differentiae specificae* within the various classes of proto-numbers. And what the continuous lines in Table_3 form can only be called a quasi-proto-structure.

So far the association of natural numbers with the general structure of trans-classic logic has been comparatively simple because the logical properties of identity and difference (or iteration and accretion) we dealt with could easily be expressed in quantities of places, symbols and partitions. If we approach trito-structure and its context of individual morphograms, the problem of associating natural numbers with logical structure becomes more intricate. The location of a symbol at a specific place in a sequence was totally irrelevant in proto- and deutero-structure. But the exact localization of a given kenogram is precisely what distinguishes one individual morphogram from another within a given deuterogrammatic class.

A short reminder of a characteristic stipulation of our traditional methods of counting – be they binary, ternary, decimal or having any other radix or base – will be necessary. In order to be able to continue the process of counting indefinitely it is assumed that an unlimited number of empty places for writing down numerals will be at our disposal. These empty places are visualized to extend from right to left and, to represent the process of counting notationally, we fill them with the available numerals proceeding from right to left. As everybody knows only the places which have been filled are relevant for determining the magnitude of the number. The potential infinity of empty places waiting to be filled and located left of the last place which has been filled does not contribute anything to the characterization of the number. The places on the left merely constitute an infinite background of total indeterminacy against which we do our counting.

Table 5



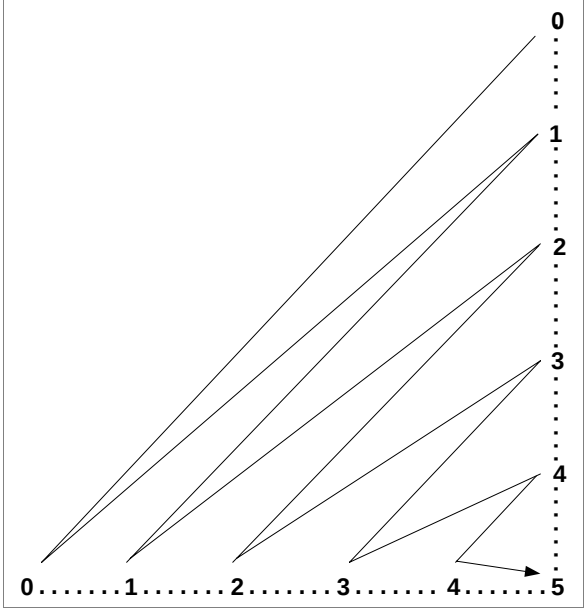
An arithmetic notation for trito-structure requires us to drop the assumption that counting trito-numbers is done against such a backdrop of total indeterminacy. In other words: not only the places on the right side of the first numeral which takes occupancy in one of the empty places are relevant for the characterization of the number, but the empty places on the left side, still waiting to be filled, also count. This, of course, means that we must be able to enumerate them. Their availability is limited. It follows that the association of the binary method of counting with the eight classic symbol sequences or morphograms implies the stipulation that we use a number system with only four empty places available for occupancy by numerals. In Table_5 we have shown, first under a) the abstract sequence of empty places starting at the right and extending to the left into infinity; under b) the mapping of the binary notation of natural numbers onto the four and only four places available for the eight classic morphograms; under c) the first four steps of mapping a number system with the radix 3 onto four-place morphograms. Table_5b demonstrates that the mapping of a number system with the radix 2 onto the classic morphograms is feasible because Mere is a close structural affinity between this notational system and classic logic-which was already noted by Leibniz. But there is no similar affinity between the ternary system of counting and three-valued logic. This is evidenced in Table_5c where we have braced the second and third number together. Both numbers represent the same morphogram and consequently the same trito-number. It is here that the limitation of empty places which we stipulated makes itself' felt. The two configurations which we have braced together could and would represent different numbers only if we assume that they belong to a system in which the number of empty places is infinite and that the places on the left side of the numerals did nothing for the characterization of the number. On the other hand, a morphogram is, as the term intends to convey, a 'Gestalt'. And it is the

intrinsic character of a Gestalt that it is finite. The infinite Gestalt is a *contradictio in adjecto.*

In our traditional systems of numeral notation we are completely at liberty to choose as many numerals as we like. It is a mere matter of expediency. This is not the case in systems of trito-numbers. If the number of empty places available by stipulation is n and we do not count the empty place itself as a numeral, we always require n-1 numerals – not more and not less. If we use more, our system would be structurally redundant. If we use less, it would be incomplete. However, this rule would not only permit but even require the introduction of the numeral 2 and also 3 into the four-place arrangement of Table_5c. What we obviously need is an additional specific stipulation about the introduction of a new numeral. In our traditional methods of notation a new numeral will be introduced (if available) immediately after its predecessor has been written down. In the case of trito-numbers, however, the introduction of a new numeral must be restricted by an additional rule. To illustrate what we mean we turn again to Table_5c. We shall ask ourselves the question: how is it possible to introduce. the numeral 2 without producing structural redundancy within the four available places? For every numeral or numerals we have written down, we have reproduced these four places again and again, so that they form together an oblong area of as yet undetermined length. Within this area we may count our empty places horizontally as well as vertically. And in order to determine a place within this area we shall say that it is the nth place, counting either from right to left or from top to bottom. It is obvious that the introduction of 2 will not cause a redundancy if the structural configuration into which 2 is placed is different from the one into which we have inserted 1. But it is obvious in Table_5c that 2 was inserted in exactly the same structural configuration (four empty places) as the numeral 1 was inserted. This can easily be avoided by carrying the number 1 from the first horizontal place to the second. This produces a new structural configuration, and we may start counting again within the vertical sequence of the places on the extreme right side. This will carry us now legitimately to the numeral 2. In other words, the numeral 2 may be and must be introduced immediately after the numeral 1 has occurred directly above *and* on the left side of the place in which we want to put down 2. This means we must count our numerals along two Cartesian coordinates as shown in Table_6.

Table_6

"Two-dimensional" sequence (.....) of natural numbers and their arrangement as quasi Peano-sequence (W↘)



The two Cartesian coordinates in Table_6 are indicated by dotted lines into which we have inserted the decimal numerals up to 5. Our counting process,

however, does not carry us along one of the coordinates; it follows instead the zigzagging line that starts with the 0 at the top and transports us finally to 5. Since we are at liberty to introduce as many numerals as we wish, it is possible to continue our zigzagging sequence without any limit. However, the introduction of a new numeral interrupts this apparent continuity structurally and establishes a new finite system of trito-numbers.

Table_7

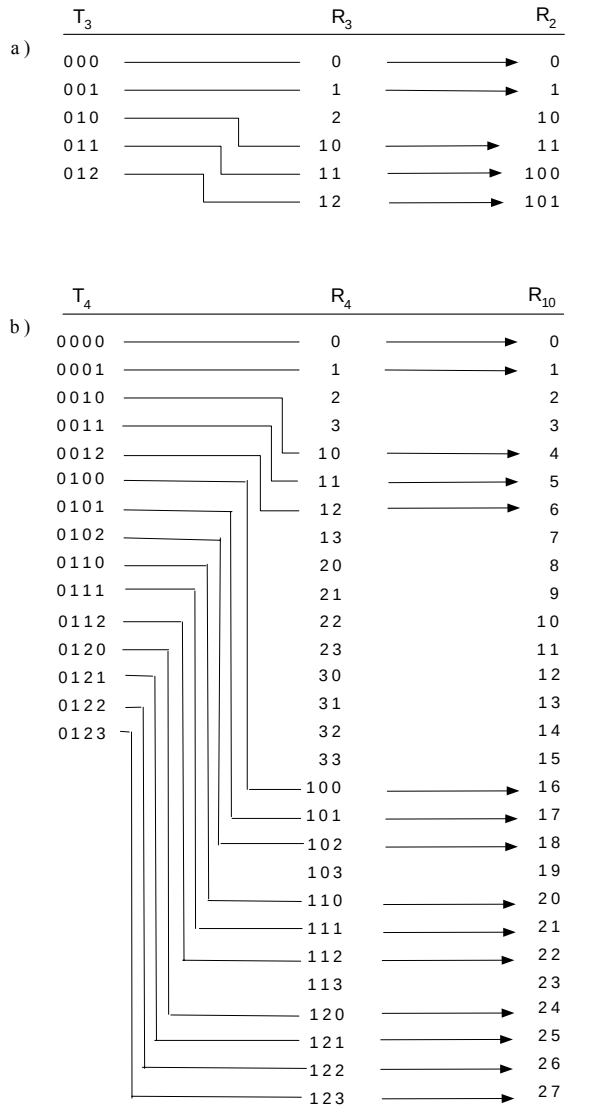
morphograms	trito-numbers	binary equivalents	decimal equivalent
a	0	... 0 | 0	... 0 | 0
a a	0 0	... 0 | 0	... 0 | 0
a b	0 1	... 0 | 1	... 0 | 1
a a a	0 0 0	... 0 | 0	... 0 | 0
a a b	0 0 1	... 0 | 1	... 0 | 1
a b a	0 1 0	... 0 1 | 1	... 0 | 3
a b b	0 1 1	... 0 | 1 1 | 1	... 0 | 4
a b c	0 1 2	... 0 | 1 0 | 1	... 0 | 5
a a a a	0 0 0 0	... 0 | 0	... 0 | 0
a a a b	0 0 0 1	... 0 | 1	... 0 | 1
a a b a	0 0 1 0	... 0 | 1 0 | 0	... 0 | 4
a a b b	0 0 1 1	... 0 | 1 0 | 1	... 0 | 5
a a b c	0 0 1 2	... 0 | 1 1 | 0	... 0 | 6
a b a a	0 1 0 0	... 0 | 1 0 0 0 | 0	... 0 | 1 6
a b a b	0 1 0 1	... 0 | 1 0 0 0 | 1	... 0 | 1 7
a b a c	0 1 0 2	... 0 | 1 0 0 1 | 0	... 0 | 1 8
a b b a	0 1 1 0	... 0 | 1 0 1 0 | 0	... 0 | 2 0
a b b b	0 1 1 1	... 0 | 1 0 1 0 | 1	... 0 | 2 1
a b b c	0 1 1 2	... 0 | 1 0 1 1 | 0	... 0 | 2 2
a b c a	0 1 2 0	... 0 | 1 1 0 0 | 0	... 0 | 2 4
a b c b	0 1 2 1	... 0 | 1 1 0 0 | 1	... 0 | 2 5
a b c c	0 1 2 2	... 0 | 1 1 0 1 | 0	... 0 | 2 6
a b c d	0 1 2 3	... 0 | 1 1 0 1 | 1	... 0 | 2 7

Table_7 presents the initial four of these finite systems. In the first column on the left side we find the morphograms to which the number systems belong. It should be noted that the morphogrammatic sequences are not written vertically, as was done in Table_1. but horizontally in order to conform with the method we adopted for writing the trito-numbers. All trito-numbers are written out with the full complement of zeros which belong to a given system. The second system of trito-numbers which encompasses only two numerals is the one from which our traditional system of natural numbers issues. It is the kenogrammatic basis of a genuine Peano sequence. In the third column from the left the binary equivalents of the trito-numbers are given and in the extreme right column the decimal equivalents. In both cases we have adopted a somewhat unusual way of writing down our numbers. In order to conform with the methods of writing the trito-numbers which always start with the 0, our binary and decimal equivalents are preceded by a short sequence of dots, ending with a 0, separated from the numbers proper by a vertical line. The vertical line separates the numbers themselves from what we shall call: their place-designator. The place-designator is supposed to indicate, in the case of Table_7, that these numbers are written against a backdrop of an infinity of zeros which have to be available in order that the numbers may extend from right to left as far as it is required by the indefinitely increasing magnitude. No place-designator is required for the separate systems of trito-numbers in the second column, because they are not written against such a backdrop. Each system has its predetermined length and width and cannot extend any further.

On the other hand, if we combine the separate systems of trito-numbers into a quasi-Peano sequence, such sequence will, under certain circumstances, i.e., if combined with other number sequences, also require a place-designator, since its extension has no limits. The adding of a place-designator is not required in classic mathematics, because the natural numbers it employs are, logically speaking, always written against this backdrop of a potential infinity of zeros. In other words, the logical place of the traditional Peano numbers cannot change, since they appear only in one ontological locus.

The situation is different in a trans-classic system. In this new dimension classic logic unfolds itself into an infinity of two-valued subsystems, all claiming their own Peano sequences. It follows that natural numbers-running concurrently in many ontological loci-must then be written against an infinity of potential backdrops. This suggests that the place-designator, shown in Table_7, is by no means the only one.

Table_8



Our last Table_8 offers an opportunity to study the changing of the binary and decimal equivalents of trito-numbers in various trito-grammatic systems. The method of finding the equivalents for any conventional number system is very simple and demonstrated in Table_8 for trito-grammatic numbers of three (T3) and (T4) places. In order to find the equivalents of a conventional number system with the radix two (R2) we confront, first, our three-place trito-numbers with the notation of a number system with the radix 3 (R3), as we have done in Table_8a. We connect then the numbers of (T3)-omitting the zeros on the left-with the corresponding. notation in (R3). If we do so we skip the single numeral 2 for which there is no correspondence in (T3). Since the equivalent of 2 in a ternary system (R3) is 10 and 2 has no equivalent in (T3), 10 also of (R2) has no equivalent in (T3). Thus, no arrow pointing to an equivalence goes from (R3) to (R2). In table_8b the same method is applied to find the equivalences of a system with the radix 10 (R10) with four-place trito-numbers. This time, the intermediate step is, of course, provided by a quaternary system (R4). All quaternary numbers without notational correspondence in (T4) are omitted and the remaining arrows point to the decimal numerals that correspond to the four-place trito-numbers.

To conclude this presentation it should be emphasized that the foregoing remarks do not imply a full-fledged theory of the behavior of natural numbers in a trans-classic system of logic. Their only aim is to draw attention to a specific arithmetical problem in the cybernetic theory of biological systems. The mythological contra-position of body and soul is nothing but a terse expression for the background of total discontexturality against which living systems have to be analyzed with regard to their basic structure.

So far Western scientific tradition has been exclusively concerned with the theory of a universe which presents to us an aspect of unbroken contexturality. The theory of such a universe is equivalent with the theory of auto-referential objects. Their nature was explored and so exhaustively described that we have practically come to the end of this epoch of scientific inquiry. A living organism, on the other hand, is a cluster of relatively discontextural subsystems held together by a mysterious function called self-reference and hetero-referentially linked to an environment of even greater discontexturality. In order to integrate the concept of discontexturality into logic we have introduced the theory of ontological loci. Any classic system of logic or mathematics refers to a given ontological locus; it will describe the contextural structure of such a locus more or less adequately. But its statements – valid for the locus in question – will be invalid for a different locus. To put it crudely: true statements about a physical body will not be true about the soul ... and vice versa.

A philosophic theory of cybernetics would imply that the total discontexturality between dead matter and soulful life which the classic tradition assumes may be resolved in a hierarchy of relative discontexturalities. We repeat what we stated at the beginning: our system of natural numbers is valid within the context of a given ontological locus, but it is not valid across the discontexturality which separates one ontological locus from the next. However, there is a way to connect a Peano sequence of natural numbers in one ontological locus with the Peano sequence in a different one. This connection is expressed arithmetically and with different degrees of complexity in the proto-, deutero- and trito-numbers. These number systems do not refer to the contexturality of a given ontological locus but to a universal substructure that connects these loci with each other. Thus these numbers have, what we shall call, an inter-ontological semantic relevance. The terms Life, Self or Soul have always been mysterious, because they refer to an inter-ontological phenomenon. Since the classic tradition knows only a single ontology it has no theoretical means at its disposal to describe phenomena which fall, so to speak, between different ontologies. The philosophical theory on which cybernetics may rest in the future may well be called an inter-ontology. But its description – as Kipling would say – is another story.

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Gotthard Günther [*]

Number and Logos

Unforgettable Hours with Warren St. McCulloch

The author of these remembrances (from now on only the 'author') feels painfully that he is in an awkward position. He intends to show a side of Warren McCulloch which is not very well – if it all – known and which hardly becomes visible in the publications of this very great man and first rate scientist: we refer to his importance and profundity as a philosopher. He was aware and very intensely so – of Cybernetics as a discipline *sui generis* that needed a novel philosophic foundation to distinguish if from the conventional disciplines. This conviction of his finally led to the meeting with the author – a contact which lasted almost a decennium. The quandary the author finds himself in stems from the fact that he entertained and still entertains almost identical views about the relation between cybernetics and philosophy as McCulloch and finds it therefore almost impossible to perform a clean separation of his own ideas from those of McCulloch. He is only sure that the thoughts he expressed on cybernetic topics are fully his own up to the publication of his "Cybernetic Ontology and Transjunctional Operations" which came out in 1962. Although McCulloch is already quoted in this essay it was done solely with the intent to appeal to his authority for ideas which the author had entertained for quite a while.

The contact between the author and Warren McCulloch was established after Dr. John Ford, then at the George Washington University, had given McCulloch in 1959 a German paper of the author "Die aristotelische Logik des Seins und die nicht-aristotelische Logik der Reflexion" which had come out in Germany in 1958. He is still intensely grateful to Dr. Ford for having made this connection which was bound to change his total outlook on philosophy. However, it took some time before he really understood what had attracted Warren McCulloch to his paper. It was not so much its potential applicability to cybernetics but a hidden relation that it revealed between number and logical context. When the author wrote it he opined that a non-Aristotelian Logic is nothing but a place value system of innumerable logical sub-systems of Aristotelian (two-valued) character. His interest was at that time wholly conceptual and he did not even dream that a hidden arithmetical issue might lead into deeper foundational layers of Cybernetics. Here McCulloch was far ahead of him.

Their intellectual collaboration started in earnest when some evening the author had made a stop-over on his yearly trip to New Hampshire – McCulloch led the talk to the Pythagoreans and their theorem that numbers describe the ultimate core of Reality. Although the author pressed for a detailed explanation all he was told at that time was that to find out more was exactly his own business. It was the first time that the author encountered a peculiar reticence of McCulloch's regarding ontological or – more precisely – 'metaphysical' questions. It led him to grossly underestimate McCulloch's gifts and intuitions in this direction. He was confirmed in his faulty judgement when he noticed that McCulloch never bothered to make corrective remarks when a paper which was read at a congress or symposium where he was present obviously implied

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metaphysical assumptions which had to be partly or totally wrong. First he assumed that McCulloch was not aware of it; later however the author knew better. Nevertheless he must confess that during the whole duration of his acquaintance and – as the author hopes friendship McCulloch never gave up his reluctance to criticize the course cybernetics was taking with relation to Philosophy. Only after McCulloch's death he learned that his mentor in Cybernetics had been as dissatisfied as he himself with the lack of fundamental ontological orientation that characterized – and still characterizes – the pursuit of cybernetic theories. But he came to understand very soon how much McCulloch saw his own endeavors within a novel metaphysical frame. The revelation came one evening when McCulloch started to talk about Martin Heidegger and produced a copy, very shabby and dilapidated from intensive use, of "Sein und Zeit".

The book had originally belonged to his friend and co-worker Eilhard von Domarus, so he explained; he in his turn had studied it carefully and he now wanted to give it to the author for renewed study because the latter had confessed that he did not care very much for Heidegger's philosophy. The expression of thanks for the unexpected present must have sounded rather reluctant because McCulloch grew very eloquent and insisted that the "Nichts" (Nought) in Heidegger's philosophy was precisely the ontological locus where the central problem of cybernetics was located, namely the mapping of the process of Life onto matter per se inanimate. BEING is both: subject and object as well; but western philosophy has fallen into "Seinsvergessenheit" (oblivion of ultimate Reality) since the time of the Greek. Which in McCulloch's view meant: it did not focus on the problem of cybernetics. In classic philosophy mere objectivity without self-reference is mistaken for "Sein". When McCulloch commented on Heidegger with these remarks the author knew he had underestimated his philosophical gifts. His detailed knowledge of "Sein und Zeit" and especially his discussion of this "Nichts" gave the author's metaphysical thinking a new direction and made him look for the roots of Cybernetics in the ultimate and primordial recesses of the Universe.

Since the spiritual contact point between MeCulloch and the author happened to be their common interest in the transcendental relevance of logic in other words: how much and what information logic conveys about the world that surrounds us – it was only natural that the author wanted to know from his partner what he meant by the term 'metaphysical'. For a start he was referred to the "Mysterium Iniquitatis ..." and the notions that "prescribe ways of thinking physically about affairs called mental ..." It stands to reason that this answer left the philosopher dissatisfied and it surely did not cover McCulloch's own – very ambivalent appreciation – of Heidegger. This was admitted; and then MeCulloch started to express thoughts which went far beyond the metaphysical references imbedded in papers like the "Mysterium Iniquitatis" "Through the Den of the Metaphysician", "What is a Number..." and others. He drew the author's attention to the fact that any logic or calculus Man may ever conceive is nothing but a more or less competent formalization of ontological concepts. This ideas was, of course, not new and may be easily extracted from his writings as ever present implication. But it showed that he had wandered much deeper into the grottoes of metaphysics than he was inclined to express explicitly in his papers. At this juncture the author thinks it fitting to remind the reader of the quotation of Clerk Maxwell appearing in "Through the Den of the Metaphysician" about the relation between thoughts and the molecular motions of the brain: "does not the way to it lie through the very den of the metaphysician, strewn with the bones of former explorers and abhorred by every man of science?" McCulloch comments this quotation with a "Let us peacefully answer the first half of this question 'Yes', the second half No', and then proceed serenely."

While there can be no doubt that he never abhorred the den of metaphysics his texts show a pronounced reluctance to analyze in detail the accoutrements of Transcendence. On the other hand, this reluctance disappeared almost completely when speculating on the pertinent issues in the presence of a person who was much more at home in the realms of the Transcendental than in the empirical ways of Cybernetics as happened to be the case with the author.

From Heidegger's "Nichts" the discourse went to Kant and Hegel. The author must confess that he was somewhat surprised when he discovered that McCulloch understood that Kant's philosophy closes an epoch of philosophical thought and that Hegel opens a new one. He knew this, of course, himself, – that was after all his business – but he had interpreted it in terms of the distinction between 'Natur- and Geisteswissenschaft' and the pseudo-systematic development of the latter in the Hegel-Renaissance since 1900. Of the Hegel-Renaissance and its concomitant intellectual events McCulloch was hardly aware. Even if he had been familiar with it: the metaphysical gap between matter and mind or subject and object which was emphasized by the Geisteswissenschaft could not be accepted by any cyberneticist, least of all McCulloch. Consequently, he explained the distinction between Kant and Hegel by pointing out the different view of Dialectics entertained in the Critique of Pure Reason and in Hegel's Logic. Kant deals with Dialectics in the sense of the Platonic tradition and in the Critique of Pure Reason the dialectic argument ends in the transcendental illusion as the unavoidable admixture of error that infiltrates all metaphysical assertions. Thus Kant's evaluation of Dialectics is basically negative and the less we imbibe of this poisonous drink the better off we are. For Hegel, on the other hand, he explained, the dialectic structure is a legitimate element of thought as well as of objective existence and it furnished the transcendental link that connects both. Seymour Papert has referred to this situation when he reports in his Introduction to the Embodiments of Mind that McCulloch insisted "that to understand such complex things as numbers we must know how to embody them in nets of simple neurons. But he would add that we cannot pretend to understand these nets of simple neurons until we know – which we do not except for an existence proof – how they embody such complex things as numbers. We must, so to speak, maintain a dialectical balance between evading the problem of knowledge by declaring that it is 'nothing but' an affair of simple neurons, without postulating 'anything but' neurons in the brain. The point is, if I understand him well, that the 'something but' we need is not of the brain but of our minds.. namely, a mathematical theory of complex relations powerful enough to bridge the gap between the level of neurons and the level of knowledge in a far more detailed way than can any we now possess." (p. XIX)

After the author had read this introduction he asked McCulloch whether he really intended to introduce dialectics only in a loose and logically non-coercive manner or whether he realized that Hegel employed the term as a linguistic cover for a hidden exact mechanism which the Universe as a whole employed but which we were still incapable of unravelling. McCulloch remained silent for a few moments and then asked the author to rephrase the question, which the latter did by simply inquiring whether he thought that the term 'dialectics' merely referred to a quirk or weakness of the human mind or whether it indicated an intrinsic property of Reality. This time McCulloch answered that the term should designate an objective quality of the universe and he added: I think this is what separates Kant from Hegel. The author and McCulloch agreed that the "so to speak" in the lengthy quotation above was not a proper expression because it suggested only a vague analogy. It did not indicate that in

the term "dialectical" a very precise systematic foundation problem of mathematical theory was at hand.

The author cannot now remember how the talk got to a paper of Barkley Rosser "On Many-Valued Logic", which was published in the American Journal of Physics (Vol.9,4; pp. 207-212, 1941), and from there to the question whether a dialectical analysis of natural numbers might help to bridge the gap between the level of neurons and the level of knowledge which is conveyed by present mathematical theory. Everything was still very vague, and it took an almost nightlong discussion to clear the realm of discourse somewhat. It helped greatly that McCulloch was familiar with the distinction of number by Plato and Aristotle and how much nearer to the Pythagoreans Plato's ideas were than those of Aristotle. And then he surprised the author by saying that, what Hegel meant by number was a not very successful attempt to rebuild again the general concept of numerality which had been divided by the antagonism of Platonic and Aristotelian philosophy. He finally added that Hegel failed to develop a novel theory of mathematical foundation because he thought more about number in the Aristotelian than in the Platonic sense. This was a most astounding conclusion and seemed questionable to the author. He believed that he knew more about Hegel and felt unable to accept McCulloch's thesis. Since the whole history of mathematics from the Greeks to the present time owes all its success to the instinctive acceptance of the Aristotelian way of thinking about numbers McCulloch had to be wrong. The author left Shady Hill Square somewhat dissatisfied and went skiing.

Six weeks later he was back, very contrite and humble. He was not a mathematician, only a logician, moreover reared in the atmosphere of the Geisteswissenschaften. But it had, in the meantime, dawned upon him how much better a philosopher McCulloch was when the mind turned to the problem of the transcendental relation between mathematics and the Universe. Conceding McCulloch his Hegel interpretation the discussion doubled back to the essay of Barkley Rosser. Rosser's attempt seemed now extremely interesting; Rosser had demonstrated in his paper, that one can get numbers from four ideas in two-valued logic which have been formalized in terms of a likewise two-valued calculus. The first idea is 'conjunction' (... and ...); the second idea is 'negation' (not ...); the third idea is 'all'; and the final idea is 'is a member of'. Rosser then suggests a projection of these ideas onto the structure of a many-valued calculus. For the purpose of demonstration and to retain a comparative simplicity he exemplifies his case with a three-valued logic. As values he chooses 'true' (T), 'probable' (?), and 'false' (F). McCulloch and the author agreed that this interpretation of three-valuedness has proved its usefulness in cybernetics and elsewhere but that it could not lead to a trans-classic theory of natural numbers because it has been established since at least 1950 (Oskar Becker) that the introduction of probability or modal values destroys the formal character of a logical system. For if strict formality is insisted on any such spurious many-valued system reduces itself automatically to a two-valued calculus. In order to convince McCulloch that Rosser's approach to the problem needed a weighty correction the author pointed to something which he considered Rosser's second mistake. The latter determines conjunction in classic logic by the following matrix:

	T	F
T	T	F
F	F	F

and the stipulation that T is not permitted to re-occur in any of the empty places which originate if we extend the places for the functional result from 4 to 9. Thus he defines, in strict analogy, three-valued conjunction by the matrix:

	T	?	F
T	T	.	.
?	.	.	.
F	.	.	.

We repeat: in order to retain the meaning of conjunction T is not to go in any of the empty places which are left open in the above matrix. However (?) and (F) may go indiscriminately in any of the other squares. Since 8 squares are left to be filled and since two choices are available in the case of each square there are 28, i. e. 256 possible choices for filling the squares. in Rosser's opinion all of them represent the general meaning of conjunction in a three-valued logic. This claim was easily refutable if one recognized – as McCulloch did – the interpretation of trans-classic logic as given by the author in his "Cybernetic Ontology and Transjunctional Operations". In order to demonstrate Rosser's too generous interpretation of conjunction the author filled out the matrix in the following way:

	1	2	3
1	1	3	3
2	3	2	3
3	3	3	2

In order to avoid the ontological consequences which are implied in Rosser's use of the symbols T for truth, ? for probability or modality, F for false we have denoted the values in the same order with the first three integers. This choice of values is quite in accordance with Rosser's stipulation for the meaning of conjunction. However, there it not the remotest chance to interpret this arrangement as a matrix of a conjunctive functor. To render a minimum sense of conjunction a three-valued logic would have to retain the structural feature of conjunctivity in at least one of the two-valued alternatives 1 or 2,2 or 3, or 1 or 3. This is not be case, because or the two-valued system encompassing the first and the second value we obtain the morphogrammatic structure which can only be filled by trans-junctional value-occupancy. For the two-valued system constituted by 2 and 3 we obtain a morphogrammatic structure for value-occupancy which is demanded in the case of equivalence, and for the final two-valued system the morphogrammatic structure of transjunction re-occurs.

But let us, for argument's sake, assume that Rosser is right and we have to deal with 256 possible kinds of conjunction in a three-valued system. What shall we do with this embarrassing wealth? Rosser himself gives the answer: "Apparently the only thing that can be done about the matter is to pick out the 'and' that one likes best, *and try to ignore the rest*." Emphasis by G. G.). McCulloch pointed out that the arbitrariness which Rosser suggested could not be tolerated in the development of a more basic theory of natural numbers. But he added meditatively: It hints at something in the relation between matter and form. The author is not quite clear whether this was McCulloch's exact wording; at any rate, he asked his mentor what he meant and McCulloch spun a long tale which seemed to the hearer to go far beyond what he had learned from the essay' "What is a Number that Man may know it ...?". Finally a spark of tentative understanding jumped from the speaker to the listener. McCulloch was talking about Hermeneutics and about the possibility that, if numbers were subject to hermeneutic procedures in the sense of Dilthey's 'Verstehen' in the Geisteswissenschaften, this would definitely close for the scientist the gap between Nature and Geist. The idea of a basic 'arithmetization' of the Geisteswissenschaften seemed to the author at that time

not only bizarre but outrageous and he voiced his violent objections. McCulloch did not answer any of them; he only asked curtly: and what do you make of Rosser's "sidewise motion"? (The reader who is not familiar with this paper should be informed that Rosser said in his somewhat loose manner that the mapping of natural numbers on a many-valued logic produces something like a "sidewise motion" of these numbers.)

It is the purpose of this essay to present the author's theories but to show the philosophic profundity of McCulloch and the author's spiritual indebtedness to him. So we shall return to the remarks McCulloch made about subterranean relations between arithmetic and the hermeneutics of the humanities. From Dilthey McCulloch went back to Hegel as idealist and materialist were equally untenable because Idealism and Materialism both implied that they were sets of statements about *what there is* instead of what the universe *means* to the brain. In any case Hegel's philosophy recognizes an existence as a context of stateable facts. In this respect Hegel was still dependent on Immanuel Kant who "spawned two fertile succubi" as we read in "The Past of a Delusion", One was "the Dynamic Ego as Unconscious Mind. Upon (it) Freud begat his bastard, Psychoanalysis. The other, causality, the Category of Reason, flitted transcendentally through Hegel's Dialectical Idealism." Upon Causality herself Karl Marx begat his bastard, Dialectical Materialism. "The author being a stout defender of the Theory of Dialectics then asked McCulloch whose opinion of dialectics in the "Embodiments of Mind" seemed to be extremely low whether dialectics would play a role in a not ontological, but hermeneutical alternative of idealism and materialism. McCulloch conceded that there might be something to it provided a satisfactory interpretation could be found for the "indeterminate duality" ἀόριστος δνάζ of Greek philosophy. According to Aristotle's metaphysics Plato called the forms numbers and stated that each number has two constituents: the One or unit which Aristotle defines as the formal constituent; and something which he calls a material constituent. This is supposed to be the mysterious ἀόριστος δνάζ. It stands to reason, of course, that dialectics has its root in a duality. So a renewed and critical analysis of dialectics should start from here. McCulloch seemed to be very well versed in these antecedents of number theory but he voiced some doubt whether the problem of the indeterminate duality was as yet properly understood. He was ready to admit that the testimony of Aristotle seemed to be unimpeachable with regard to what Plato *said* but it seemed to be a different question as to what Plato really *meant*. The author who had studied the relevant passages in Aristotle's metaphysics could not help imparting to McCulloch his impression that Aristotle totally misunderstood Plato's reflections concerning the theory of numbers. Aristotle himself refers to the lectures Plato delivered in the Academy as the "unwritten doctrine" (ἄγραφα δόγματα) which means that Plato did not produce a written text of his academic teaching. Therefore his listeners handed on several different versions of his famous lecture on "the Good" which has intrigued students of Plato up to the present time.

McCulloch was intimately familiar with Alfred North Whitehead's essay "Mathematics and the Good". Whitehead keeps quite close to the tradition which connects the Platonic "duality" with the "indefinite" or the "unlimited" (ἄπειρον) of the Pythagoreans. Whitehead interprets this in the following way:

"The notion of complete self-sufficiency of any item of finite knowledge is the fundamental error of dogmatism. Every such item derives its truth, and its very meaning, from its unanalyzed relevance to the background which is the unbounded Universe. Not even the simplest notion of arithmetic escapes this inescapable condition for existence." ("Essays in Science and Philosophy" 1947, p. 101.)

McCulloch could not agree entirely with this viewpoint. Seymour Papert correctly pointed out that the famous 1943 paper by McCulloch and Pitts demonstrated that a logical calculus that would permit the embodiment of any theory of mind had to satisfy "some very general principle of finitude". McCulloch was thinking of some such limitation in the indeterminateness of "indeterminate duality" when he questioned the traditional and conventional interpretations of Plato's ideas on numbers. It was clear to him that in this respect the difference between Plato and Aristotle is basically this that Aristotle permitted only one single concept of number, producing a gradual accumulation of uniform units (μοναδικόζ αριδμόζ), but that Plato's philosophy involved a *second concept* of number resu1ting from the break between the real of ideas and our empirical existence. He became very insistent that the author should delve deeper into the philosophical aspects of number theory when the latter told him about Hegel's speculation on a "second" system of mathematics "welche dasjenige aus Begriffen (erkennt), was die gewöhnliche mathematische Wissenschaft aus vorausgesetzten Bestimmungen nach der Methode des Verstandes ableitet". (Hegel, ed. Glockner IX, p. 84.) With this idea of a "second" system of mathematics in the background McCulloch began to urge the author to develop his ideas on the connection between number and logical concept further. Very soon an agreement was reached that the starting point should be the fact that the notation of the binary system of numbers coincided in an interesting way with the method by which two-valued truth tables demonstrated in the propositional calculus the meaning of logical concepts like conjunction, disjunction, implication and so on. It was only necessary to reduce the value sequences to their underlying morphogrammatic structures of which eight could be obtained in order to see that there was a peculiar correspondence between the method by which the binary numbers from 000 to 111 were produced and eight 4-place morphograms which used only the idea of sameness between places or difference.

We do not have to repeat all of the next steps here because they have, almost without philosophic background, been reported by the author in Vol. I. in the Journal of Cybernetics. Almost – which means that the formal philosophical concept of *universal contexture* at least was introduced. But neither Plato's ἀόριστοζ δνάζ nor Hegel's idea of a "philosophische Mathematik", as logically distinct from traditional mathematics, was alluded to. There was also no reference to a general principle of finitude which had been most essential for the production of the afore-mentioned essay in the Journal of Cybernetics. In fact, the essay could never have been written without the information the author was given by McCulloch about some of his ideas on finitude. The author shall try to repeat what his memory retained because what McCulloch developed in the case of the dialogue seems to deviate from the trend of thought emerging in the "Embodiments of Mind".

After a tentative discussion of Hegel's trans-classic concept of mathematics McCulloch turned back to the problem of finitude referring to a then recent paper by C. C. Chang "Infinite-valued Logic as a Basis of Set Theory". (Logic, Methology and Philosophy of Science, North Holland Publishing Company, Amsterdam, pp. 93-100, 1965.) He agreed with the author that Chang's paper had to be criticized from the viewpoint of finitude, and that Chang assumed willy-nilly the philosophical theorem of Łukasiewiez that only three systems of logic have ontological relevance: the two-valued system, the three-valued order and a system with an infinite number of values. He admitted that Łukasiewiez's conclusion was quite consistent and reasonable provided one places all values added to True and False "between" these two classical boundary cases of value. That a two-valued logic and a system with an infinite number of values have ontological relevance is beyond question. But why in addition to them

only a three-valued system? This assertion of Łukasiewicz may be interpreted as follows: Since the number of values between True and False represents the continuum, any individual value in the middle that is selected out of the totality of values can only be obtained by a Dedekind cut. This cut, and *not* the number obtained by it, is the proposed third value! Thus, if we add a fourth and a fifth and a sixth and so on intermediate value we would only iterate in logical respect the information of the cut. And since – to say it again – the cut itself is the third value and not the results of the cut. The iteration of the cut would, despite a different numerical result, produce logically (and not arithmetically) speaking the same value. Seen from here it makes sense, if Łukasiewicz maintains that only to three systems of logic philosophical meaning can be attached. The talk then turned to the fact that the author had shown in several papers that many-valuedness might be interpreted differently. Denoting all values by integers and starting with 1 one might place all transclassical values not "between" 1 and 2 but 2 "beyond" 2. This "beyond" leads inevitably to a different interpretation of many-valued systems.

At this point the author wants to note that during the initial stage of investigating many-valuedness he had believed that the idea of placing additional values totally beyond the alternative of True and False was the *only* legitimate ontological interpretation of many-valuedness. It was McCulloch who disabused him of this erroneous belief. He drew his attention to the fact that in a many-valued system designed according to the author's concept of many-valuedness being an order of ontological places of two-valuedness any two-valued system could *additionally* contain Łukasiewicz' values between True and False. Later on the author has found this suggestion extremely useful and only recently it has helped him to understand a specific phenomenon of trans-classic logic which, otherwise, might have been uninterpretable.

At this time, however, the new insight in many-valuedness did not lead very far. For the time being there existed only a general agreement between McCulloch and him that the term 'many-valuedness' was ambiguous. The theory had to consider the fact that two different kinds of many-valuedness had to be distinguished[1]. Beyond this result there was still much haziness. It was about the time when McCulloch was playing with the idea of the "Triads"[2] , and the author distinctly remembers the day when McCulloch told him: "Gotthard, you can do everything with triads!" The author did not agree; there was too much of the small of Post and Łukasiewicz around this statement. However, he remained silent; McCulloch sounded too emphatic. It must have been the right diplomacy, because later – the author cannot remember the length of the interval – McCulloch declared with equal emphasis when the author based an argument on three-valued relations: "Triads are not enough". The author can guess what caused this change of attitude. First, the return of the discussion to the paper of Chang, and second, a renewed analysis of the meaning of number in the Platonic system. We shall start with Chang. He introduces in his paper a set X which is referred to as the set of truth values of the infinite-valued logic. For the purpose of discussing finite-valued logics he considers a sequence of finite subsets of X, such that for each X_n

1 Cf. G. Günther, Die Theorie der "mehrwertigen" Logik: in Philosophische Perspektiven, Ed. R. Berlinger & F. Fink, Frankfurt/ M. 1971; III, p. 131.

2 See Christopher Longyear: Towards a Triadic Calculus, I - III, Journal of Cybernetics, 1972, pp.50-65, 7-25 and 51-78.

$$X_n = \left\{0, \frac{1}{n-1}, \frac{2}{n-2}, ..., 1\right\}$$

Each set X_n, is regarded as the set of truth values of an n-valued logic. If n=2, all functions will, of course, acquire their traditional two-valued character and meaning. The viewpoint underlying this procedure is exactly the same as taken by Łukasiewicz. All values of this pseudo-transclassic logic have their ontological location between the boundary values 0 and 1. In other words: they refer to finite subsets of the continuum. This makes it impossible to eliminate infinity from the basic philosophic theory of logical values.

On the other hand, human awareness as the source of logical-value-and-natural-number theory is a *finite* system of the brain ("Why the mind is in the Head"). Although the system is finite it may produce as its mental content such second order concepts as denumerable and non-denumerable Infinity. If the author understood McCulloch properly then the latter took an extremely revolutionary position. Hitherto philosophers had always – without further questioning – assumed that the Finite is embedded in what we call the Infinite McCulloch seemed to imply that this order should be reversed and that infinity should be robbed of its primordial rank and only be admitted as a second order product of a finite system of awareness which is a product of the equally finite system of the physical brain. It became clearer and clearer to him that McCulloch's ultimate concept of the entities which made up Reality was not so much the Realm of Ideas – be that in the Platonic or in the Aristotelian-Hegelian sense – but the 'Pythagorean" conception of Number although his notion of numerosity had, in the course of the years, drifted away from the position which was taken in "What is a Number, that Man may know it". So at least it seemed to the author. When he first meditated about number it happened against the as yet unquestioned metaphysical backgrond that in order to define Reality one must understand that all Finitude is embedded in the Infinite. When the author saw him last McCulloch seemed to have completely reversed his position. He seemed to believe that ultimate Reality could only be understood in terms of Finitude, and that Reality conceived as infinity was nothing but mythology. The author was led to this conclusion by the discussion of Whitehead's "Mathematics and the Good". Which, of course, led directly to Plato's lecture περὶ τἀγαθοὐ and the modern attempts to reconstruct the text.

Plato starts with the question: what are the ultimate building stones of the Universe? The conventional interpretation of Plato is satisfied with the somewhat crude answer that these building stones are the Ideas. But if the ideas represent no ordered system in the shape of a pyramid, with the single idea of the Good on top, and a plurality of other ideas below, the problem of the metaphysical Number emerges and we are carried beyond the domain of Ideas to the ultra-ultimate question: what is the relation between unity and the manifold? In other words: our thinking cannot stop till it reaches the concept of what is conventionally and vaguely known as the natural number. It was immediately clear to McCulloch that our conventional interpretation of the order of natural numbers as a Peano sequence could not satisfy the philosophical reflexion because it was absurd to interpret the order of the Ideas also as a Peano sequence. From the idea of the Good they spread out in an arrangement that was more or less inadequately described as a pyramid. The reports on Plato's lecture unfortunately do not make it clear how Plato himself interpreted the relation between Number and Idea. McCulloch as the cyberneticist interpreted it for purely systematic reasons as a reduction. The analysis of the Ideas leads to a pre-ideative system of only numerically definable relations. An alternative interpretation – traceable back to antiquity –

that Ideas are just numbers he did not like. The ideas could not be the ultimate building stones of the universe – they were much too complex. It was unfortunate that neither McCulloch nor the author were aware of the fact that shortly before they entered into their discussion about natural numbers the German philosopher Klaus Oehler had published (in 1965) a paper under the title "Der entmythologisierte Platon" Zeitschr. f. Philos. Forschung XIX, pp. 393-420). This profound essay seems to have anticipated McCulloch's position. What Oehler says is so important that it may be repeated at this point. "Die Entfaltung der Einheit zur Vielheit und die Teilhabe des Vielen an dem übergeordneten Einen bestimmen den gegliederten Aufbau des Ideenkosmos. Nun geht aber weder der Aufstieg zu den umfassenden Begriffen ins Unendliche fort, noch geschieht das bei dem Abstieg zu dem Einzelnen. Der Aufstieg ist begrenzt durch den allgemeinsten und umfassendsten Begriff, das ἐν der Abstieg ist begrenzt durch das jeweils letzte εἶδοζ. Das bedeutet aber, daß die Ordnung der Ideen zahlenmäßig bestimmt ist. Folglich ist jede Idee durch die Zahl von Inhalten, die sie umschließt und an denen sie teil hat, eindeutig festgelegt. Jede Idee ist also durch eine Zahl bestimmt und ist als solche zahlenmäßig bestimmbar, angebbar. Diese numerische Fixiertheit verleiht der Ordnung der Ideen ihre rationale Klarheit, ihre Durchsichtigkeit und Übersichtlichkeit. Ist das Mannigfache der sinnlichen Wahrnehmung nur durch die Teilhabe an der Idee das, was es ist, so ist die Idee nur durch die Teilhabe an der Zahl das, was sie ist. Mithin muß die Zahl vor der Idee sein. Die Ordnung der Zahlen ist der Ordnung der Ideen übergeordnet, weil überlegen. Das bedeutet aber: die Ideen sind nicht das Letzte und mithin nicht die Prinzipien des Seienden."

(The unfolding of the one into the manifold and the participation of the manifold in the super-ordinated One determine the structure of the cosmos of Ideas. But neither does the ascent to the comprehensive concepts continue into infinity, nor does this happen in descending to the Particular. The ascent it limited by the most general and the most comprehensive concept, the ἐν, the descent is limited by the last particular εἶδοζ. That means that the order of ideas is numerically determined. If follows that each idea is univocally defined by the number elements it contains and in which it participates. Consequently each idea is characterized by a number and is as such numerically describable (and quotable). This numerical fixation endows the order of ideas with its rational clarity, transparency and orientability. If the manifold of sensual perception is what it is only by participation in the idea, then the idea is what it is only by participation in Number. Thus Number must be prior to Idea. The order of Numbers is super-ordinated to the order of Ideas, because it is more potent. This means: the ideas are not ultimate and therefore not the principles of Being.)

It is not difficult to see that Oehler leans toward the notion of finitude, which was so dear to McCulloch, when he points out that the ascent to the One as well as the descent to the Particular are always finite. That does not exclude, of course, that each such finitude may be superseded by numerical increase of the finitude. Infinity, however, is nothing but the everlasting subjective expectation that every given finitude is not the last one. *It is a mistake to ascribe ultimate ontological relevance to the concept the Infinite*. It seems to the author in retrospect that McCulloch in expressing such thoughts moved into the neighborhood of mathematical intuitionism and its criticism of the transfinite or actual (extensional) non-finitude. Existence is constructibility, logically speaking.

Excursus

Before we discuss the quotation from Oehler it will be not only desirable but necessary to introject into the report on McCulloch an excursus on the meaning of the term 'number'; because a modern mathematician will probably object to the way this concept has been handled so far not only by McCulloch but by the author and Oehler as well. The question one has to begin with is the following: why did the concept of number become so important for Plato after the doctrine of Ideas had reached some maturity? The likely answer is, that during the development of the doctrine of Ideas, the quest for the individual ideas lost more and more of its importance in favor of the inquiry into the inter-connectivity and systematic order of *all* the ideas. This led automatically to the search for the most general and, at the same time, elementary form of order. This would, of course, be the linear order mentally accomplished by the simple process of counting. But already the Pythagoreans had discovered – and Plato was familiar with Pythagorean number theory – that this most primitive order was capable of a highly sophisticated treatment which permitted ultimately to encompass any element of ordering the not-yet-ordered.

Such concept of order transcends the principle of quantity by far and such transcendence may be determined in many ways. McCulloch only insisted that any principle of order should be traceable back to the familiar order of natural numbers. Whether we let the natural numbers begin with 0 or 1 is, of course, a mere convention. However, there should be no confusion between the metaphysical Nought and the conventional 0 or 1 in numbers. These distinctions remained in the discussions with McCulloch always somewhat vague; but he left no doubt that he never considered the gap between number and concept as ultimate but was convinced that it could be bridged. This was for him the significance of transcendental philosophy which he believed would produce the unification of the humanities and the sciences. Both of them – so he argued – start from a common ground: the elementary unit which in its primordiality is indistinguishable from any other unit. Thus primordial units are per se unordered and for this very reason they may be used to produce a system of order for the Realm of Ideas. But even at its very beginning Greek mathematics encountered an almost unsurmountable problem: how to understand the relation between unit in the geometrical and in the arithmetical sense. In the Pythagorean mathematics of the fifth century the geometrical point was made to correspond to the arithmetical meaning of 1. In other words: the number 1 that which designated a real point in the objective world. A point is the minimum quantity which we encounter. The difficulties that arose from this viewpoint are too well known to mention them here; it is sufficient to draw the attention to the fact that Aristotle nailed this epistemological attitude down with the formula μονάζ ἐκουσα δέσιν (the unit with location).

At this point the dialectical mechanism of all reflection makes itself visible, and the argument emerges that a point as identified with the number 1 is not a minimum volume of objectivity, but the absence of objectivity. In other words: *to produce as number as a quantity a duality is required.* As soon as this insight is obtained the thought will tend to let the point correspond rather to 0 and not to 1.

> If in modern times we insist that it is irrelevant whether we call the first number 0 or 1, this may be a convention in one way; but it is not a convention in a different way because it points to the peculiar relation between primordial unit and Nought.
>
> It would be tempting to spin a consistent yarn how McCulloch connected his many philosophical ideas on Number with each other. Yet this would falsify the situation and the author refrains from doing so.
>
> The connection with Oehler's Plato interpretation seems rather obvious. The difference between the geometrical and the arithmetical meaning of number presents an unresolvable ambiguity which paradoxically renders numbers a suitable structural basis for philosophic thought and thus a possible link between the sciences and the humanities.
>
> Since primordial units are totally indistinguishable from each other they are totality indifferent as building blocks of thought against the distinction between the sciences and the humanities, as we pointed out above. Conceptual distinctions can only be generated by changing the principles of ordering units, and an order is always a matter of interpretation. If the primordial unit is interpreted as a point in space and ontological interpretation is chosen, and if we consider 0 as the idea with which we start our familiar number sequence we have reversed our interpretation and our first symbol designates – to speak in Platonic terminology – not an objective unit but the subjective act of starting to count (διαίρεσιζ).
>
> From this dichotomy the way leads either to the sciences or to the humanities.

With this thesis that not the Finite is embedded in the Infinite but that the Infinite – be it conceived as potential or actual – is, in the metaphysical sense, only a subordinated element of Finitude McCulloch showed himself to be a first rate metaphysician. This view of Metaphysics had never occurred to the author though he had always prided himself of having effected in his: "Cybernetic Ontology..." a metaphysical breakthrough from classic tradition by means of the rejection value. But McCulloch went much farther with his reversal of the mutual role of Finitude and the Infinite. Whenever classic tradition through the history of Philosophy discussed the meaning of the Absolute a philosopher would have deemed to have lost his senses if he had proclaimed that the Absolute is a Finitude and that the main characteristic of the empirical world is its Infinity. Unfortunately, McCulloch did not elaborate this point in detail. And the author did not press him very much because he hoped to have, later on, a better occasion to elicit a detailed explanation of this startling and paradoxical theorem. Alas, this opportunity never came.

There was just a hint of an explanation in his evaluation of the Platonic confrontation of the One and the ἀόριστοζ δνάζ, the indeterminate duality. He approved of Aristotle's opinion that this duality was nothing but a material constituent. To put it differently: a number is an entity which is produced by the actual determination of determinable potentiality. And the vehicle of the determination is always the One. McCulloch agreed with this Aristotelean interpretation but not wholeheartedly. He told the author again and again that this way of thinking overlooked something and did not account clearly for the difference between the step from 1 to 2 in the familiar sense of Peano sequence and the step from Oneness to Duality in the other sense that Duality already implied an unbounded manifold. It had been noted before that Aris-

totle seems to be confused about the difference between the "indeterminate duality" and the number 2 (A.E. Taylor; Plato, N.Y. 1927, p.512); knowing this McCulloch's arguments gained a greater weight with the author than they would have done otherwise. He decided, startled by the novel metaphysical viewpoint of McCulloch, to attempt a new interpretation of natural numbers on the basis of a many-valued logic with a kenogrammatic background. He sought and obtained McCulloch's agreement not to follow the way of Barkley Rosser but to choose a different method. There was nothing in Rosser's paper on undetermined duality, whereas McCulloch and the author agreed that the meaning of this term was the key to the whole problem. Aristotle's lack of the understanding of the problem led to a position where he could only recognize what he called 'mathematical number' which is nothing but what we have called Peano numbers. The other numbers, the numbers of Platonic ideality, which define the Platonic order of ideas would not possess any logical legitimacy if we wanted to follow Aristotle. This, according to McCulloch, was unacceptable because the order of the Peano numbers was intrinsically incapable to reproduce the conceptual wealth of the system of Ideas. In McCulloch's opinion Rosser was still and Aristotelian in his number theory. When the author, with some trepidation, decided to leave pure logic for the time being and tackled number theory he was warned from some other side that his lack of mathematical training could only lead to an abysmal failure. With his first sketch which he called proto-numbers he went to McCulloch and told him of the warning he had recived and made no bones about his mathematical incompetence. However, he was at the same time able to point out that the same argument could have been applied to the corresponding efforts of the mathematicians. Since Frege there had been strenuous efforts to give mathematics safe logical foundation but it could hardly be denied that the logic underlying these efforts nowhere went beyond Leibniz at best and that neither the transcendental turn effected by German Idealism nor the problem of dialectics and its destinction between Platonic and Hegelian dialectics was properly understood on the side of the mathematicians. Here stood incompetence against incompetence and it could only be hoped that a better cooperation between mathematics and philosophy would produce something worth while. McCulloch encouraged the author to continue who took it as part of the encouragement that McCulloch invited two or three friends and collaborators of his to whom the author should present his ideas. He has now forgotten who else attended but he remembers that Professor Manuel Blum was present. Taking into consideration everything McCulloch had said about the indetermined duality and also including the result of discussions on Hegel the author took the following step toward a transclassic theory of natural numbers. Guided by Hegel's dialectics he said that the process of adding 1 to a preceding number was ambiguous: it could either be interpreted as "iterative" or as "accretive". Starting from 1 and proceding to 2 the duality thus obtained was indeed indeterminate but not in the sense which Plato, according to his interpreters, might have intended. Interpreters have usually been of the opinion that for Plato going from 1 to 2 was only the step from Oneness to Manifoldness and that the indeterminacy of the manifold which this step established was not positively fixed. It could be anything: 2, 3, 4 and so on.

The argument against this interpretation is that it does not lead to dialectics and Plato was a dialectician. His doctrine of ideas clearly shows a dialectic structure and if the order of the ideas is determinable by numbers then *the numbers themselves must display a dialectic structure* also. This was a consequence McCulloch had not only admitted in the discussions with the author. More so: he had pointed it out to him before the latter had become aware of it. The dialectical treatment of natural numbers –

'dialectic' in the combined meaning of Plato and Hegel – implied that the process of addition 1 + 1 = 2 should be interpreted in two ways: one could either look at the two 1's as being identical or as being non-identical. This could be done by either ignoring the fact that the second 1 was a repetitor of the first 1 or by not ignoring the repetitional character of the second unit. The result is different in both eases. No matter which interpretation was chosen the result would, of course, always be a duality. But duality would carry two meanings; it was important to express this in a way that the difference in meaning would become computable.

At this point the author was helped by a stray remark McCulloch had made a year ago the importance of which the author had previously overlooked. McCulloch said that the difference of meaning seemed to him a difference of quality in the sense in which Hegel differentiated at the beginning of his Logic between Being and Nothingness as antithetical qualities. Only in this way could one understand how dialectics might finally turn qualities into quantities. The author found this remark extremely cryptic and asked McCulloch how this dialectic transition might happen. He got the disappointing answer: This is for you to find out. At a renewed attempt to extract at least some shreds of information pertinent to the problem the author was only reminded of a former discussion about Heidegger and his treatment of the Nichts[3]. This he considered no help at all. But then he found his attention drawn back from the concept of number and directed towards the idea of the kenogram. Kenograms are empty places which may or may not be occupied by values. Up to this point the author had always believed that only one value at a time could occupy a single kenogram. Not it occurred to him that a kenogram might behave differently in the ease of numbers, and that it might be the ontological locus not just for a single number but for a total Peano sequence of natural numbers. And since a Peano sequence is of infinite extent such numerical order would be a demonstration of McCulloch's startling metaphysical thesis that not the Finite is encompassed in the Infinite but that all Infinity must be understood as a subordinated element of Finitude, i.e. a kenogram. The author was so excited by his brainwave that he did what he had never done before and as far as he can remember never did afterwards, he rang McCulloch up to ask his opinion. Contrary to his expectation McCulloch was not swept off his feet but asked all sorts of question how a single kenogram could be defined as an all-encompassing domain accomodating a never ending process of counting. There was nothing in the original conception of a kenogram, so McCulloch reminded the author, that would suggest such property. The author must confess that he felt deflated when he hung up. But his respect for McCulloch's mental acuity was so great that he settled down immediately to think the problem over. Very soon his initial disappointment turned into deep gratitude, because out of McCulloch's critical remarks the concept of the universal contexture was born. The author is convinced that he would never have found this idea if he had not been privileges to listen to McCulloch's thoughts about the metaphysical rank of Finitude and the information given over the telephone. Re gratefully acknowledges that McCulloch is as much the creator of the concept of universal Contexturality as opposed to mere context as the author of this essay. For this reason it seems to be fitting to describe here the difference between a mere context and a universal Contexture.

If, e.g. in court the question is raised whether the defendant is guilty or not guilty, it would be non-sensical to answer: no, he is broad-shouldered. In other words: the alternative guilty or not guilty is enclosed in the context described by the statutes of

3 See also: Martin Heidegger, Was ist Metaphysik? Frankfurt/M. 1951, pp.22 to 38.

criminal law. On the other hand: the question: 'Is the growth in this person malignant or non-malignant?' cannot be answered by: 'No, he is a poet', because the alternative which has been raised belongs to the context of pathology. In both cases the answer must be guided by a tertium-non-datur which refers to a superordinated viewpoint which in our first ease was criminal law and in the second pathology. The alternates of a context may be very narrow and again they may be of ever increasing generality, the alternative still constitutes a mere context as long as it is possible to determine a superordinated viewpoint. A context changes into a universal contexture only on condition that it is impossible on principle to find a superordinated viewpoint which defines the meaning of the tertium-non-datur for the opposites for which the superordinated common viewpoint has been sought. The classical example for this situation is Hegel's "alternative" between Being (Sein) and Nought (Nichts). They are alternatives which exclude each other. Nobody can deny it. Yet nobody can conceive of a metaphysical concept that would be of greater generality than both of them. In other words: both constitute separate universal contextures. We are not able to understand the distinction between Sein and Nichts as alternatives *within a context*. The question: of what context? must in this ease remain unanswered. Similarly we read in Lenin's works that for the opposition of Mind and Matter no common denominator of higher generality can be found. Mind and Matter are not elements of a context. They are universal contextures, capable of encompassing contexts with limited alternations. Lenin concludes from this insight that the thinker who has arrived at this alternative has come to an end of his theoretical way. He is only left with the decision to declare himself either an idealist or a materialist. This is not the place to sit in judgment of the legitimacy or illegitimacy of Lenin's conclusion but his example shows that the situation Hegel discusses at the beginning of his Logic can turn up under radically different aspects[4].

If the reader thinks that these reflexions are far from what we read in the "Embodiments of Mind" he may be reminded of the insight the essay "A Heterarchy of Values determined by the Topology of Nervous Nets" conveys. There we learn that "an organism possessed (at least of six neurons) is sufficiently endowed to be unpredictable from any theory founded on a scale of values.. It has a heterarchy of values, and is thus internectively too rich to submit to a *summum bonum*."

A summum bonum requires an ultimate hierarchy of values with an absolute value at the summit. Logically this means that there must be a tertium-non-datur crowned by a final common denominator of 'Sein' and 'Nichts'. If somebody insists that such a denominator is inconceivable the hierarchist will willingly agree but explain that this ultimate common denominator is nothing but God himself, as the Lord of a *monocontextural* Universe. McCulloch's heterarchy of values, on the other hand, postulates a reality that is only conceivable in a poly-contextural sense. In other words: the world we live in cannot be understood as an unbroken universal context. In fact, the term 'universal context' is in itself a *contradictio in adjecto*. It may be true that the author finally formulated the difference between context and contexture, but it is also true that he could never have done it without the spade work McCulloch had provided.

In fact, there is another way to show how near McCulloch came to develop the distinction between context and contexture. He had an amazing knowledge of medieval logic and he once referred to the famous ninth chapter of Peri Hermeneias and its

4 Cf. G. Günther, Life as Poly-Contexturality in: Wirklichkeit und Reflexion. Festschrift für Walter Schulz (H. Fahrenbach Ed.), Pfullingen (Neske) 1973, pp.1 87-210.

influence on medieval logic up to William Occam. Aristotle had stated that in logical terms the difference between Past and Future could he defined by the fact, that the tertium-non-datur is valid for and applicable to all the Past. With regard to any Future the tertium-non-datur is equally valid, bui it is not opplicable. McCulloch considered this distinction very important for the understanding of the present, and it shows how near he came to distinguish between context and contexture because, if we refer to the Past, we refer to what has happened in a context. Thinking about the Past we always mean the actual contents of a contexture, thinking ahout the Future, however, we can only refer to an as yet empty universal frame which has not yet been filled with any contents because, if it were, it would not be the Future. Writing down these lines the author wonders how far he is perhaps plagiarizing McCulloch. Because he is convinced that his own thoughts might not have gone in this direction if he had never had the good fortune to have those long nocturnal talks with McCulloch.

It was not always easy to listen to him, because his way of thinking was seasoned, as Seymour Papert rightly remarks, "with a very personal flavor" which not unfrequently led to misunderstandings. One example was his pronunciamento that Finitude should he given metaphysical priority over the Infinite. The author is by no means sure that he has caught the full meaning of what McCulloch really intended by this statement. It is much too simple an assertion to describe an involved situation correctly. But it was one of the suggestions which helped him to arrive at his own distinction between a contexturality and its potential contents. A universal contexture is a finitude insofar as it is only one piece in a patch-work of an unbounded multitude of contextures. It is limited by its borderline to a neighboring contextural domain, but its capacity for content is unlimited owing to the peculiar character of its tertium-non-datur. When talking about the metaphysical priorities of finitude and infinity McCulloch casually mentioned Heidegger's "Seinsvergessenheit". If the author understood him properly – which is by no means certain since the morning was dawning and he was overtired – then Heidegger's "Seinsvergessenheit" must not be understood as a term referring to the contexture 'Sein' but to its contents only. On the other hand, when the talk focussed on Heidegger's 'Nichts' it was a foregone conclusion that the contextural frame was referred to, because it would have been nonsensical to speak of the actual contents which nothingness might encompass.. Further, it must be understood that the expression 'universal contexture' was understood that the expression 'universal contexture' was not used either by McCulloch nor the author at that time because neither was ready for it. Instead of it rather involved circumlocutions were used. However, trying to distill from his memory what seems to him the essence of the discussion the author finds it easier to use this more precise term which assuredly was a result of the mental exchanges between McCulloch and the present reporter.

During the last meeting the author had just returned from his yearly skiing vacation – it was agreed that he should write a paper on natural number theory within the frame of trans-classic logic for the next meeting of the ASC in Gaithersburg. The author remembers he had grave doubts that his paper would be ready for the third Annual Symposion of the American Society for Cybernetics. In consequence of his misgivings he informed McCulloch that he did not yet know whether he would be able to offer something in time to the Society. It turned out later that his pessimism was unjustified and he completed within the deadline the second part of the text which later appeared in the July/September issue 1971 of the Journal of Cybernetics. McCulloch did not know it; he had been in Europe during this period and when he returned he asked Dr. Edmund Dewan whether the promised paper had been handed in. This the author was

told by Dr. Dewan on the first day of the Symposion which McCulloch could not attend because he had died on Sept.24, 1969 in Old Lyme, Conn.

When the paper was finally published with a Part I preceding the original text now designated Part II the writer added a footnote that the ideas expressed in the first part were to a great extent the result of a night session he had with McCulloch toward the end of February 1969. Since then 5 years or more have past. and his memories of McCulloch have gained a new dimension. He knows now how much more he owes to McCulloch than this footnote expresses. The maturing of his memories has shown him among other things that McCulloch's influence did not only extend to one part of the aforementioned essay but to the other part as well. It was one of the remarkable gifts of this great man and scholar that he developed in his associates ideas and mental trends which they themselves might never have brought to fruition unassisted. The author of these remembrances has endeavoured to show how McCulloch, by delving deep in the philosophic aspect of Finitude elicited from the brain of his listener the conception that the Universe we live in is not mono-contextural but a network of Finitudes, partly bordering, partly overlapping, and in the case of compound contextures even encircling elementary contexturalities, in short: a polycontextural Universe. He deeply regrets that McCulloch never saw the final text in order to give or deny it his imprimatur. He feels that the philosophical impact of McCulloch's thinking is still vastly underrated even by his admirers an disciples. He was such a many-sided thinker that he appeared enigmatic, never showing all facets of his mind to a single partner in discourse. To a neurologist he was an innovator in neurology: to a psychiatrist he revealed new ideas on psychiatric problems; with a mathematician he would discuss the mathematical aspects of his work, and when he met the author it was in the den of the metaphysician.

The quantity of topics McCulloch liked to talk about was enormous and his roving mind led the listener, sometimes quite unexpectedly to connections which went far beyond conventional associations. But wherever he turned to the problem of ultimate or penultimate foundations he looked for his data in the realm of numbers and number was for him invariably linked with Finitude.

Once the general topic of discussion had been a passage in "Why the Mind is in the Head?" concerning the relation between quantity and number. There we read that 2 in so-called analogical contrivances a quantity of something ... is replaced by a number... or, conversely, the quantity replaces the number." When the author suggested that, following the example of Hegel's Logic, the triadic relation between a quantity, number, and quality would also deserve a closer look, McCulloch switched to the question: why in primitive societies the capacity of counting was often very limited. The most elementary system of counting would, of course, work only with three hazy concepts: oneness, duality, and general manifoldness. McCulloch insisted that something was conceptually wrong when Plato according to tradition included general manifoldness in the concept of duality only because duality was not longer oneness. This improper inclusion was due to the fact that classic logic permitted only two values and nothing beyond. But then McCulloch continued that, if a finite system of numbers increased by the addition of one more numerical concept it would no longer be the same system to which a new numerical unit had been added, but it would be, logically speaking, in its totality a new system of counting! And every time one more unit was added this was not an adding process in the conventional sense in which we increase a given quantity by adding just 1. Instead, by addition we abandoned the numerical representation of a given conceptual order and moved to a different conceptual relationship with a somewhat higher complexity. This means that – let us say – the number 3 in a numerical

order that went up to 4 was logically no longer identical with the 3 that occurred in a system which permitted you to count up to 5. To melt all these logically distinct systems of finite counting together into an unending Peano sequence one had to suppress most of the logical distinctions which number as a metaphysical concept implied. For this very reason number as a medium of thought had fallen into disrepute in ontology and was forced to make room for conventional language to represent metaphysical concepts.

The author must confess that for one reason or another he had forgotten these remarks when he wrote "Natural Numbers in Trans-Classic Systems". But the memory came painfully back to him when later on he tried to apply his number concept to Hegel's system of Dialectics. Only then did he realize that McCulloch's startling statement that a 3 in a system which permits counting only up to 4 is logically not identical with the 3 in a system where the count up to 5 is permitted was linked to the fact that even in its own order of numerality a given number loses something of its rigid identity when the numbers are mapped onto a many-valued logic. It was obvious that, even by mapping numbers onto a trans-classic system of logic, they could not change their positions, "lengthwise". A 3 remained always a 3 and could not move to the place of 4. Thus 1+1 remained always 2, but if the position of 2 was not a fixed point on a, so to speak, horizontal line, one could always ask: at which locus of the line the 2 was located. Thus, according to the location, the number could have different meanings. In other words: any number system of finite length represented itself to a philosopher as a hermeneutical order. Thus even the number 2 was already open to conceptual interpretation. Seen from here it was obvious that a system of higher numerality offered more chances of interpretation in a metaphysical sense and that therefore every time a successor number was added the previous system was semantically discarded, which meant that each specific world concept had its own numerical system fitting its own philosophical requirements. If at this stage we use the term 'number' it should be understood that we do not mean what Aristotle calls "mathematical" number or "number made of 1's" (μοναδικοζ ἀριδμόζ) but what we shall call here the esoteric number following terminological usage in which the lectures of Plato which he did not write down himself have been frequently called his esoteric doctrine. The indeterminate duality, e.g. is such an esoteric number. And so is any number which measures the distance between the universal One (ἐν) and the last particular εἰδοζ pertinent to the occasion. It is obvious that the Aristotelian numbers count empirical things or data of the world we live in and that the esoteric (Platonic) numbers are only concern with the realm of Ideas.

Many comments made on the difference between counting in the Aristotelic and the Platonic sense remained very hazy to the author at the time he heard them and he is not certain how much of what he has still to report on the philosophy of numbers is McCulloch's or his own understanding of the problem. It should also be added – and this troubles him very much in retrospect – that in his talks with McCulloch neither ever referred to the concept of a kenogram[5]. This has been very annoying to him in two respects: first, in order to get on paper what he had learned from McCulloch on numbers he found it unavoidable to use kenogrammatic structures and second, since not even the term was ever used, there was not opportunity to ask McCulloch what he made of the difference between numbers *within* the space of a kenogram and numbers *counting* the kenograms. Since then, the issue has become extremely important, much

5 Except in a phone-call.

more than the author had anticipated in former years, and this again impedes his memories of McCulloch's fundamental philosophic concepts. He is only certain that McCulloch during his last period would have agreed with Klaus Oehler's statement: "If the manifold of sensual perception is what it is only by participation in the Idea, then the Idea is what it is only by participation in Number. Thus Number must be prior to Idea. The order of Numbers is superordinated to the order of Ideas because it is more potent".

This association of esoteric Number with Idea seems to require another agreement with Oehlers Plato interpretation that esoteric number sequences are completely dominated by the principle of finitude. When we refer in every day life to natural numbers we assume automatically that they form an unending sequence. But if we trust Oehler's interpretation no Platonic system of esoteric numbers ascends an endless way toward the One, nor can it happen that it descends into the bottomless.

Thus peculiar dialectic situation is produced for the earthly thinker. He has the choice of interpreting the Peano sequence of numbers as an ultimate dilution of the orders of esoteric numbers to a degree where they become unfit for the representation of philosophic problems and where they are only good for showing money amounts in cash registers or temperature grades on the scales of thermometers and for similar trivial tasks. But we can also look at them as the material from which we build up orders of esoteric numbers starting from systems with minimal complexity to ever increasing structures of higher order. This produces a scale that proceeds from finitude to finitude! An infinite system of esoteric numbers is inconceivable. If trying to think it we cannot help but apply the numbers of the Peano sequence – which means: we drop out of the realm of metaphysics.

What has just been said is important to elucidate the philosophical radicality of McCulloch's principle of finitude which finally led him to the observation that the finite, metaphysically speaking, is not embedded into an infinite Absolute but that wherever we meet concepts of transcendence the latter will be finite and the Infinite will be is subordinated content.

McCulloch not infrequently remarked that it was necessary 'to lay the ghost of the Absolute', since in the philosophical tradition the Absolute and Infinity are invariably equated. Heidegger's treatment of the Nichts seemed to him a confirmation of his views. This was very difficult to understand, especially for somebody who was constantly aware of Heidegger's contempt for a thinking that arithmetizes (rechnendes Denken) and who could not forget the severe criticism McCulloch as a psychiatrist had at a different occasion launched against Heidegger and his work. The author was bewildered; but he regained some understanding when McCulloch casually remarked that Peano's definition of a progression, applied to the system of natural numbers, tacitly assumed that we know what Zero is. It was this remark which helped the author very much when, following McCulloch's trend of thought, he developed a system of trans-classic numbers.

In order to make clear how the author tried to implement McCulloch's comment on Zero and Nothingness it will be useful to start with Leibniz' dyadic method of counting:

Table I

1					(1)				
1	1				(2)	(3)			
0	1								
1	1	1	1		(4)	(5)	(6)	(7)	
0	0	1	1						
0	1	0	1						
1	1				(8)	(9)	.	.	.
0	0								
0	0								
0	1	.	.						
.	.	.	.		.	.	.	.	.

The left side of Table I displays the sequence of natural numbers expressed in the binary fashion; on the right side we note (always in parentheses) the same sequence in the conventional decimal fashion of writing. If we extend the method of Leibniz to write numbers to a ternary sequence of notation we obtain

Table II

1											
1	1	1	2	2	2						
0	1	2	0	1	2						
1	1	1		1	1	1	1	1	2		
0	0	0	1	1	1	2	2	2	0		
0	1	2	0	1	2	0	1	2	0	.	.
1	1										
0	0										
0	0										
0	1	.	.								

Both Tables have two characteristica in common:

a) 0 never turns up in the first place of a vertical sequence; and
b) any numeral, belonging to the system, (except 0) may turn up at any place of the vertical sequence.

Yet there is a significant distinction between both Tables: since no sequence is permitted to begin with 0 it is impossible that there will ever be structural redundance in Table I; in other words: as long as we stick to two symbols our representation of a Peano sequence cannot be negated, without violating our first rule. Table II shows a different picture. We notice at once that in the group of the two-place sequences (this time written horizontally for convenience' sake) 1 0, 1 2, 2 0 and 2 1 are structurally (morphogrammatically) identical; so are 1 1 and 2 2. In other words: what Table II displays is not a sequence composed of kenograms. This redundance of structural characteristics would also occur in quaternary, quinternary and any subsequent Leibnizian notation of counting.

It stands to reason that in both cases (represented by Table I and II) 0 is given a very specific interpretation: it is assumed a limine that an unlimited supply of zeros is available forming an indifferent background against which numbers can be written. But zero may be interpreted differently.

However, if one attempts to write down with more or less chance of success an adequate representation of the esoteric numbers of Plato one has to abide (using as a mere convention the same kind of symbols) by two principles: first, every number must

begin with 0 – as an initial symbolic expression, designated as such and no other symbol may be placed in the notation unless the symbol of counting in our conventional order of signs for counting 0, 1, 2, 3... has turned up at least once. This means that, e.g., a fourplace sequence, 0 1 2 1, is a legitimate expression. 0 2 1 1is not, because it only repeats the morphogrammatic structure of the first four-place sequence. It follows that a system of esoteric numbers would have an approximately pyramidic shape and that every horizontal layer would represent a relatively independent numerical system beginning with 0 and ending with the highest number which is structurally permissible in the system.

Peano had used three primitive notions:

nought
number
successor.

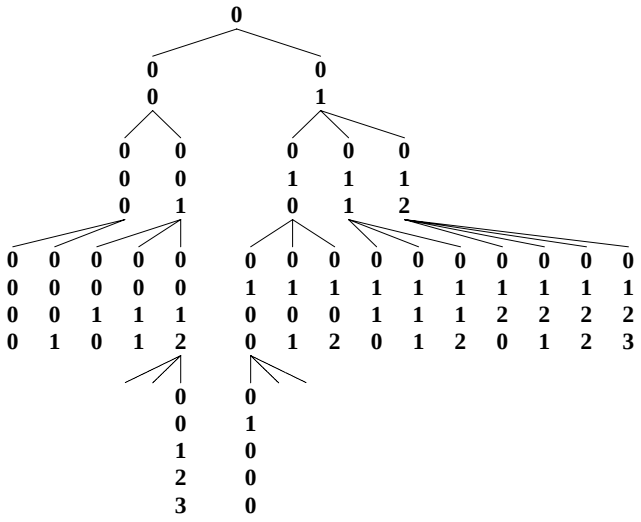
Since nought represented no quantity, it was self-understood that his expressions had always to begin with a number denoting a measurable quantity. Nought represented only a boundless background against which numbers could be placed. This meaning of nought, of course, changes, when the distinction between foreground and background becomes irrelevant in an attempt to use a quantitative order of symbols to represent *structure*. It stands to reason that such a combination of quantity and structure must always have a highest number. And since McCulloch had at least approved of the distinction between iteration and accretion it was always a question how many structural differences can be accommodated between the 0 of accretion and its maximum.

Table III represents an attempt to display a Platonic system of esoteric numbers for a maximum of four places. It is the equivalent of one section of Table VII in Part II of "Natural numbers in Trans-classic Systems". Whether it would have found the approval of McCulloch as a representation of some of his ideas we will, alas, never known.

Table III of this report gives at least an inkling of what McCulloch might have meant with his ruminations that every way to understand the Absolute must be finite; but, on the other hand, Table III also suggests that some caution is needed if we want to reverse the classical thesis that all earthly existence is finitude and as such encompassed in the infinite Absolute. It is true that whenever and wherever we try to confront the Absolute the face it shows is that of finitude. But Table III also demonstrates that it belongs to the attributes of the Absolute that every finite aspect of it which we discover is followed by an unending sequence of aspects of higher complexity.

At this point an intricate problem of number theory evolves as the numbers which make up the increase of accretion are the esoteric numbers. For the numbers available to us when counting the sequence of the esoteric number systems are the numbers of the non-esoteric Peano order.

Table III



How much McCulloch was aware of this ramification of the problem the author does not dare to say. He was hoping to clear that point after McCulloch's return from Europe. He never saw him again. Nevertheless, despite all too many uncertainties about McCulloch's Weltanschauung, the author is convinced that he should be counted among the outstanding philosophical figures of this epoch. Yet it is extremely doubtful whether McCulloch would have been acclaimed as doubtful whether McCulloch would have been acclaimed as such in professional philosophical circles, had he been more outspoken on philosophic issues. His ever deepening conviction that the ultimate key word of philosophy is not Idea but Number is still anathema in the departments of philosophy as well as in the Humanities. The author himself confesses that if somebody – before he had the good fortune of knowing McCulloch – had suggested that in Metaphysics we require numbers in order to understand ideas instead of saying that ideas are necessary to understand numbers he would have more or less politely changed the topic. It took a McCulloch to show him that it had been the tragic fate of Western civilization to permit the concept of the idea to gain metaphysical precedence before number and that from this very choice the fateful split between sciences and the humanities had resulted. In McCulloch there was no such split. In the eyes of the author this courageous reversal in the order of idea and number alone makes him a philosopher of most impressive stature. It is impossible to measure the philosophical import in detail because this is a matter of future historic developments. For the time being the traditional viewpoint prevails overwhelmingly. But one may safely say that his work and the philosophic attitude underlying it has created the conditions for a total reversal of the logical foundations in the humanities, and it has set a standard for future cybernetic work. The author has never concealed his dissatisfaction with the pitiable paucity of guiding principles metaphysical in the pursuit of cybernetics. Only after McCulloch's death has he been told that he shared this dissatisfaction and did so with an equal degree of intensity. He was aware long before the author that cybernetics was not just a novel technical discipline among others but that its future pursuit implied a new philosophic concept of reality. Fundamentally it is nothing less than a new form of philosophic thinking under the guise of a particular scientific discipline because it endeavors to give to the philosophic method, via neurology and related fields, a precision it had never had before.

A short report of certain consequences of McCulloch's thinking on a domain remote from cybernetics may illustrate its philosophical relevance.

It is the area of philosophical hermeneutics as applied in history and other branches of the humanities. For the time being it seems absurd to approach hermeneutics as Dilthey and his successors understood it with arithmetical procedures. A number is always what it is, and the result of an arithmetical operation is either true or false – or undecidable. There is not the slightest room for 'interpretation'. But if we look at the numerical system evolved in the manner in which Table III demonstrates it is no longer enough to say: This is 2, this is 3, this is 4 etc. Because even if we add 1 to 1 equals 2, the question already will haunt us: which 2 do you mean? 2 in the iterative, or 2 in the accretive sense? If we read Table III from top to bottom there is no case in which a number has just one successor; it has at least two mostly, however, more. In Table III the fully aecretive version of 4 would e. g. have five successors. In order to obtain this situation nothing has been done but apply the elementary dichotomy of sameness or otherness. This has the effect that, beginning with 0, an ever increasing amount of Peano sequences of non-esoteric numbers are spreading out in different sequences of esoteric numbers. However, as far as a given system of esoteric numbers is concerned the principle of successorship is not the one which we have just describes. In these finite number sequences which we have to read horizontally every "esoteric" number has just one and only one successor – except the last which is fully accretive; it has therefore no successor at all. Correspondingly, the first, which is fully iterative, possesses no predecessor. It follows *that the principle of hermeneutics originates only the transition from one finite system to the subsequent one with increasing structural properties*. But as long as we remain on a given esoteric level the principle of single successorship holds unconditionally.

If we want to express ourselves in Platonic terms we may say that the esoteric numbers partake (μέδεξιζ) of the "mathematical" numbers of Aristotle (μοναδικοί). On the other hand, if we look at Table III and follow a sequence not horizontally but vertically we observe that the increasing multiplicity of Peano sequences is determined by the fact that every one of them crosses the horizontal order of esoteric numbers at different points. It is this concatenation of two different numerical orders that endows Number with properties which make it a useful tool for philosophy in general and especially for hermeneutics. Unless very specific and limiting conditions occur it is no longer sufficient to ask what is number, but in how many ways can it be interpreted, hermeneutically. A first step in this direction is an observation made almost simultaneously by Heinz von Foerster and the logician von Freytag-Löringhoff (Tübingen). They informed the author that the distinction between a fully iterative and a completely accretive number could be interpreted as the difference between cardinality and ordinality. In conventional mathematics it would, of course, be hard to see a hermeneutic issue in this contrast. What makes it hermeneutic is the fact that the cardinal and the ordinal number are connected by "mediative" numbers that have a cardinal and ordinal component. This requires a different way of thinking about numbers, a circumstance of which McCulloch was probably more ware than any other scientist of his time.

It had to be so. When Rufus Jones, the Quaker, asked him in his youth what he wanted to do in his life, he told him that the guiding star of his thinking would be the question of numerosity. When the author met him in the evening hours of his life McCulloch had remained true to the self-dedication of his youth.

The reference to the Platonic numbers might suggest that McCulloch was basically a Platonist. However, such judgment would be far from the mark. He was well aware that Platonism in its narrow sense belongs to an epoch of philosophic thought which

had seen its heyday. For him philosophy still oscillated between two fundamental inquiries.' is reality rooted in a last irresolvable discord or in a final coincidence and reconciliation of all contradictions? The "Embodiments of Mind" give the impression that he leaned more toward the concept of a final resolution. In the "Mysterium Iniquitatis" we read that "cybernetics has helped to pull down the wall between the great world of physics and the ghetto of the mind" and "so we seem to be groping our way toward an indifferent monism". But the author, during the very late sixties, heard sometimes statements which were not exactly in accordance with the last quotation. The author remembers one occasion when McCulloch attacked psychoanalysis with a degree of animosity and the author drew his attention to a short sentence in the "Past of a Delusion" where he had read: "Upon Causality herself Karl Marx begat his bastard, Dialectical Materialism." The author who never considered himself a Marxist but an Hegelian stoutly defended Dialectics (and never mind the distinction between dialectic idealism and dialectic materalism). For him any transcendental theory of the universe had to have dialectic structure McCulloch denied the validity of this position but he was interested enough in the issue that some sort of discussion ensued. In its course he developed some ideas which fitted in ill with his leanings toward monism. The author is not sure whether they expressed some real convictions and new philosophical insights or whether they were merely argumentative stratagems to win over his opponent and disabuse him of dialectics. The author is inclined to believe the first: but he is by no means sure about it.

McCulloch casually referred to the Buddhistic Nirvana and insisted that European concepts of Reality were too deeply associated with the idea of ,,Substance" at the expense of "Relation". As always when he talked with the author he drew his exemplifications rather from formal logic and abstract number theory and not from cybernetics proper. Commenting on his suspicion that the concept of substantiality played too large a role in Western philosophy at the expense of the problem of relationship he speculated what philosophy would look like if we stopped talking so much about ultimate building blocks of the Universe and postulated that there were no such things and that every assumed last unit was nothing but a relation of even more fundamental units and that this splitting of the building blocks was a process that could never end. As a firm believer in dialectics the author could only agree. It fits in quite well with McCulloch speculations about numbers and Finitude. On the other hand, his musings on Substance and relation do not harmonize with the concept of an "indifferent monism" because there is no transcendental 'space' in which the difference between relator and his relata may ever disappear[6].

Unfortunately, there remains a rest of doubt. McCulloch showed as usual an extraordinary reluctance to criticize the arguments of his opponent and to reveal much of his own philosophic forays into the Ultimate.

One thing seems certain, however – the philosophic position displayed in the "Embodiment of Mind" does not fully reflect what McCulloch thought during the last years of his life. He was no longer certain – as we still read in "Through the Den of the Metaphysician" – that "the seeming contradictions vanish in the grace of greater knowledge". His concept of metaphysics had deepened and he frequently made statements that were difficult to reconcile with the remark in the "Mysterium Inquitatis of Sinful Man" that notions are metaphysical if "they prescribe ways of thinking physi-

6 Cf. C. Günther, Cognition and Volition in: Cybernetics Technique in Brain Research and The Educational Process. 1971 Fall Conference of American Society for Cybernetics. pp. 119-135.

cally about affairs called mental". Many of his remarks daring the very last years would have suggested that by metaphysical terms he understood concepts which refer to a situation in which it was on principle impossible separate object and subject, including the thinker.

The author is led to this conclusion by McCulloch's reflections on the mutual logical position of Substance and Relation. There is no way in which Relation can ever be dissolved in a term of substantiality and vice versa. On the other hand. a relator and its relata depend functionally on each other, neither makes sense without reference to the other. They are – as Hegel would say – dialectically connected, and the problem of this connection defines the realm metaphysical. The author believes that McCulloch might lastly have agreed. If one shifts from the distinction between 'physical' and 'mental' in his former definition of what he would be willing to call "metaphysical" to the radically logical contrast between relation and relator it is obvious that the meaning of the term 'metaphysical' must also change. In the sense of Hegel's logic the distinction between relator and relatum can never "vanish in the grace of greater knowledge". While only relata may designate substance metaphysically the relator refers for ever to an act of subjectivity. This requires a deeper insight into the philosophical problem than cybernetics possesses at the present moment.

When the author was told that McCulloch was seriously dissatisfied with the development of cybernetics he could well understand it. But while writing this essay and trying to trace McCulloch's philosophic reflections into greater depths he has also learned to understand his reluctance to criticize the turn cybernetics has been taking. In his last years he was experimenting with new thoughts but had not reached the degree of certainty where his scientific conscience would have permitted him so speak aloud of his doubts and misgivings.

It might be possible to draw a clearer picture of McCulloch's last philosophical reflections; but this would require a greater amount of interpretation by the author – in other words: it would have been progressively more difficult to distinguish between what McCulloch had been thinking and what the author thought he did think. For this reason greater clarity and coherence has been sacrificed to the aim of at least approximate historical accuracy. The author is sure that he has not succeeded in the desired degree. He only knows that apart from Plato, Aristotle, Leibniz, Kant and Hegel – no modern philosophical thinker has exerted a greater influence on him than Warren McCulloch whose memory he shall always cherish and revere.

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Gotthard Günther [*)]

Time, Timeless Logic and Self-Referential Systems

For more than two millennia, all Western scientific thought has rested on the methodological principle of two-valuedness dividing all reality into an objective and a subjective component. The division was assumed to be exhaustive. The existence of a third value of basic ontological significance was expressly denied. The ensuing system of logic not only posed the questions but also circumscribed the range of permissible answers. One of the two available values was considered to be designative, and the other had to be non-designative in order to obtain a set of laws interpretable in ontological terms. The designative value was called positive; it pointed to the purely objective aspect of the universe. And since the non-designative or negative value could not point at anything, the trend of all Western science, based on this system of logic, has been one of progressive objectivation to the exclusion of all traces of "subjectivity "-which are implied in the non-designative value.

Unavoidably, the early Greek thinkers had to face the question: Does the phenomenon of Time belong to the objective aspect of the world, thus falling within the range of the designating value; or is Time not an element of the ultimate basis of reality, and does it, therefore, fall under the jurisdiction of the negative value?

From the very outset, the participants in the discussion disagreed. The Eleatic school of thought excluded Time from objective existence. But Heraclitus considered the static aspect of the universe as deceptive. According to him, no thing is identical with itself; its ultimate essence is an *event.* A seeming advantage of the Eleatic viewpoint became visible as soon as Archimedes appeared on the stage of scientific inquiry. With him begins a trend that G.J. Whitrow [1] has called the "elimination" of Time from natural philosophy. This trend has continued up to the present, where it manifests itself as the absorption of Time into Einstein's geometry of a hyperspace. Between Archimedes and Einstein, innumerable arguments have been advanced in favor of its elimination; and during the history of Western science, their persuasive power has grown stronger and stronger. But each argument which spoke for the elimination of Time has been countered by an equally strong one advocating the retention of Time as a basic constituent of objective reality. Especially in recent times, the pro and con arguments have grown more and more sophisticated. And if we continue along this line of inquiry, we may expect them to become even more subtle and penetrating.

However, recent developments in logic make us wonder about the genuineness of the, whole controversy. If no final answer has been found for 2000 years, we are entitled to the suspicion that there may be no answer. And this suspicion is supported by two data which the controversy of natural philosophy has not yet taken into account. First, the scientific development leading from Archimedes to Einstein was accompanied by a parallel trend the history of dialectic logic. And dialectic logic poses an entirely different question. Its first concern is not the relation of Time to Being, but the relation of Time to Logic itself. It can be shown that the discussion of Time on the basis of natural science remained incomplete

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[1] WHITROW, G. J. 1963. The Natural Philosophy of Time. : 1-5. Harper Torchbook Edition. New York, and Evanston, Ill.

and insufficient because it ignored the dialectic aspect.[2] The other datum which throws a significant light on the alternative of elimination or non-elimination of Time is the comparatively recent insight into the consequences of the isomorphic character of two-valued logic. This isomorphism is based on the principle of the Tertium-non-datur (TND), the duality of conjunction and disjunction, and the fact that in classic logic the dividing line between designation and non-designation coincides with the distinction between assertion and negation. This isomorphism has a peculiar result. It divides. all potential objects of logical discourse into two basic categories-for the first category, the isomorphism is irrelevant; for the second category, it influences the logical treatment of the object of discourse. We shall call the objects of the first category "ortho-objects" and those of the second "pseudo-objects." An ortho-object is something that can be conceived apart from anything else. An apple we eat is an example of the first category. To know what an apple is, we do not have to refer to plums or grapes. The second category contains such objects of thought as cannot be conceived without reference to some thing else. Terms referring to this category are: left and right, positive and negative, life and death, rest and motion, and also the temporal terms past and future. In these cases the meaning of one term implies the meaning of the other.. With regard to the pseudo-objects the isomorphism of classic logic has the following effect: Each statement we may make about them is refutable by a contradictory statement; for each pseudo-property we ascribe to a pseudo-object, we shall find a contradictive pseudo-property we can ascribe to it with equal right. And since Time is such a pseudo-object, we might expect the controversy to continue forever as to whether or not it is eliminable.

We shall take the following stand: It is useless to continue the controversy because the question is badly posed and can never lead to a final answer. But if the problem of Time does not permit a definite answer as long as our two-valued logic is applied to it, we have no choice but to question the competency of classic logic in this special case. Aristotle himself seems to have taken this attitude when he confronted his logic with the phenomenon of Time. The part of the Organon called "Peri Hermeneias" raises, in its notoriously obscure Chapter Nine, the question of the validity of the total disjunction between contradictive statements, if such statements refer to future events.[3] Aristotle's analysis of the problem yields two results: First, the TND is unconditionally *valid* for past as well as for future events. But it is *applicable* only to the Past and Present. It is *not* applicable if we form statements about events which will only occur in the Future. The second result of the chapter is more or less implied. Since the issue is one of applicability, the distinction between what-there-is as Past or Present and what-there-will-be as Future requires the existence of a self-referential system. Aristotle does not say so himself, but the inference was drawn in the later development of classic logic from Boethius to William Ockham.[4]

Aristotle's distinction between the validity of the TND and its applicability is unfortunately rather vague and permits two different interpretations. The first and more obvious one suggests that statements about future events have only probability or modality values filling the logical distance between false and true. This interpretation of the text was utilized for a premature attempt to develop a theory of many-valued logic. However, it has been shown that systems of probability or modality do not display a rigidly formal

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[2] Cf. J. COHN, 1963. Theorie der Dialektik. Leipzig.

[3] 18 b - 19 b.

[4] Cf. H. SCHOLZ & W. OCKHAM. 1948. Deutsche Literaturzeitung. **69**(2): 47-50.

structure and, if reduced to their purely formal constituents, revert to classic logic with full applicability of the TND.[5] It is significant that all endeavors to develop a many-valued logic on this philosophic basis have led to theories that could logically account for only a very small fraction of the enormous wealth of constants that turn up in many-valued logic.[6] These attempts, started in 1920, have now practically been abandoned.[7] However, the hints Aristotle gives about the relation between Logic and Time permit a different interpretation. Since Aristotle significantly groups Past and Present together with regard to their logical relevancy, we may say that the TND is valid, first, with reference to past events and, second, with reference to the dichotomy between Past and Future. TABLE 1 may illustrate what we mean. It displays the pattern of the classic table of negation but in an iterated form. The large table represents the total disjunction between Past and Future. Inside the larger table we find the same pattern as a sub-table, but now as an alternative between positiveness and negativeness. Both tables represent symmetrical exchange relations and testify to the unrestricted validity of the TND between the respective members of the exchange relation. It follows that, if the connection between the two tables is ignored, Time displays a basic symmetry. If both tables are made to cooperate, we obtain a logical system in which Time will display features of symmetry as well as non-symmetry.

TABLE 1 may be interpreted as a three-valued system which is composed of three two-valued subsystems. Since the Past is a context of what *did* actually happen and what *could* have happened but did not, the relation of the Future to the Past is ambiguous. First, we have a two-valued relation between the Future and the Past as what came to pass; but we have also an exchange relation between the Future and the Past as that which did not come to pass. If we add these exchange relations between values to the classic ontological exchange relation between what is and what is not, we obtain our three two-valued systems. However, TABLE 1 shows us even more. We may say that it demonstrates the application of the TND between a single value - in our case (3) - and a two-valued system represented by the values (1) and (2). We need not add that placing the subsystem ($1 \longleftrightarrow 2$) under the heading of the Past is a mere convention. One might as well interpret the Future as the potentiality of an open alternative of what might and what might not come to pass; and the Past as the one-valued singularity of what-there-is and what-there-has-been. Such interpretations serve only illustrative purposes. Nothing is relevant but the relational structure formed by these three two-valued

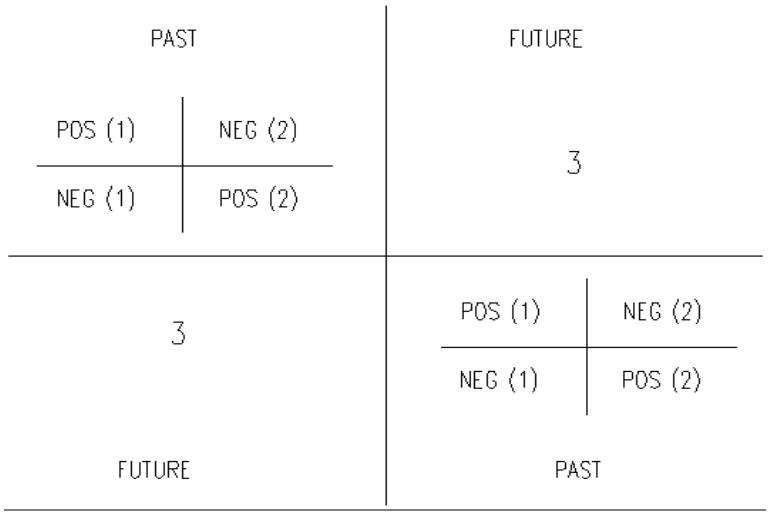

TABLE_1

[5] REICHENBACH, H. 1947. Experience and Prediction. : 319-333. University of Chicago Press. Chicago, Ill.

[6] BOCHENSKI, 1. M. 1936. Der sowjet-russische dialektische Materialismus. Dalp. (München) **325**:132.

[7] A very skeptical evaluation of many-valued logic by C. L LEWIS. 1932. Alternative systems of logic. The Monist XLII. 4: 481-507.

systems. However, for the foundation of a logic which intends to encompass the phenomenon of Time, a more basic concept has to be introduced. Classic logic is traditionally considered as the doctrine of the laws of thought. These laws are supposed to regulate the activity of a computing system or subject which maps its environment. They refer, by designation, to an outside world and, by self-reference, to themselves. In other words, the classic two-valued system represents two ontological loci which we may conventionally call Thought and Being. On the other hand, it is obvious that Time will not fit into either of them. Its two-valuedness of Past and Future is neither identical with the contraposition of affirmation and negation inside our consciousness; nor is it identical with the alternative between self-referential consciousness and objective world. This seems evident. But if the two-valuedness of Time has its ontological locus neither inside the consciousness nor in the environment of a self- referential system, we must ascribe to it an ontological locus of its own. In the case of a two-valued system, the difference between value and locus is so small that it hardly yields more than the mere distinction between logic and ontology. But the introduction of a third locus widens the gap between them sufficiently – so that a special symbolic representation for the loci is required.

We, therefore, introduce a new type of symbol which we shall call a "kenogram." Its name is derived from the term "kenoma" in Gnostic philosophy, which means ultimate metaphysical emptiness.[8] An individual kenogram is the symbol for a vacant place or ontological locus that, in conjunction with other kenograms, may form a pattern without regard to possible value-occupancy. An individual kenogram may or may not be occupied by one value at a time. To provide for the accommodation of many different values at the same time, we may introduce as many differently shaped kenograms as we choose. As symbols for values, we use positive integers. We further stipulate that a context of individual kenograms shall be written as a vertical or horizontal sequence. This affords us two possibilities. We may either repeat a kenogram of the same shape until the predetermined length of the sequence is filled; or we might choose differently shaped kenograms to fill our vertical columns. A kenogram may remain empty within the context of a calculus, or it may be occupied by a value.

For value-occupancy the following rules shall hold: kenograms having the same shape must always be occupied by the same value; the choice of the value, however, is free. Kenograms of different shape must carry different values, if any. Several kenogrammatic sequences of equal length added horizontally to each other shall form a kenogrammatic structure, provided all sequences are present which follow from its generating rule. Repetition of a sequence would constitute redundancy. The horizontal width of ascending orders of structures will be determined by how many differentiations we are ready to introduce. If we exhaust all possibilities, four basic distinctions will be available. We shall call them, in ascending order of differentiation:

proto-structure
deuter-ostructure
trito- or morphogrammatic structure
value-occupancy.[9]

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[8] Kenoma is the complementary concept of pleroma, meaning fullness. Cf. H. LEISEGANG. 1924. Die Gnosis. Körner **32**: 312-317.

[9] Cf. G. GÜNTHER. 1962. Cybernetic ontology and transjunctional operations. Self-Organizing Systems. M. C. Yovits, G. T. Jacobi & G. D. Goldstein, Eds. : 313-392. Washington. This paper contains a first description of what is called here the trito-structure.

The first three comprise the kenogrammatic range of a transclassic logic. TABLE 2 begins with a vertical minimum sequence of one place. Thus, there can be no structural differentiation either in the kenogrammatic field, nor between kenogrammatic structure as a whole and structure by value-occupancy. If we proceed to two-place sequences, there is still no differentiation between proto-structure, deuteron-structure and morphogrammatic structure. But there is a difference between kenogrammatic structure in general and value-occupancy. We notice that the two vertical kenogrammatic sequences permit four value- occupancies. If we proceed to three-place sequences, we observe that the number of columns for trito- or morphogrammatic structure has increased. Morphogrammatic structure now differs from the two preceding kenogrammatic orders. There is, however, still no distinction between proto-structure and deuteron-structure. If we finally step down to four-place sequences, the table shows the proto-structure and deuteron-structure may also be distinguished.

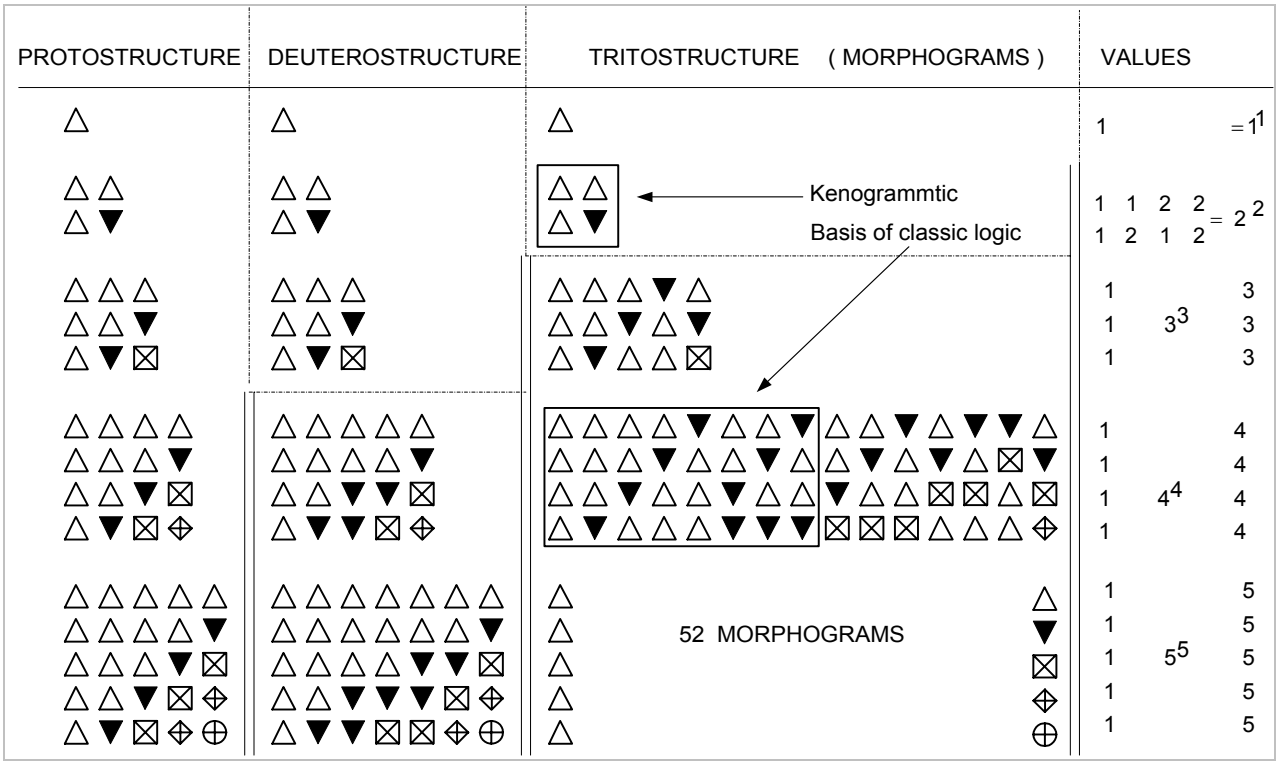

TABLE_2

Proto-structure represents the absolute minimum of kenogrammatic differentiation. In this case, we ask only how many vertical lines are required if the placing of an individual kenogram is irrelevant and if we want only the absolute minimum of kenograms to be iterated. Our placing the shapes within a sequence is entirely arbitrary; any other distribution would do as well. If we proceed to the deuteron-structure, we still consider the place into which an individual kenogram is put as irrelevant. But, whereas in the proto-structure only the upright triangle was iterated, we now ask: If otherwise the conditions of the preceding proto-structure held, what is the highest number of iteratable kenogrammatic shapes? We find that in four-place sequences (where proto-structure and deuteron-structure begin to differ), only two kenograms permit iteration. For demonstration purposes we have chosen the two triangles. The place where the iterations appear are still arbitrary choices.

In the morphogrammatic field, we finally reach the full range of kenogrammatic structure. The table of morphograms originates from the question: How many differently numbered kenograms can be put into how many places in how many ways?

We have offered this short description of TABLE 2 in order to show why, in the history of Western science, there has been a marked tendency toward the elimination of Time. The logical formalism on which the spirituality of the West is based permits only a two-valued system of logic, assuming two ontological loci represented by two kenogrammatic symbols. Thus, it was impossible to assign to Time an ontological locus of its own. One of the two available loci had to carry Time in addition to whatever else it was carrying. This imposition of Time on one of two ontological loci already occupied by Being or Thought produced an intolerable epistemological situation; and scientists since Archimedes followed a very sound instinct when they tried to eliminate Time as a basic ontological category. Two kenograms do not produce sufficient structural differentiation to give Time an equal partnership with Being and Thought. For the primordial distinction between object and subject, the stark dichotomy between empty structure and value-occupancy was sufficient; but to conceive Time as apart from Being as well as from Thought, a differentiation within kenogrammatic structure is necessary. This requires the introduction of a third ontological locus and its symbolic representation in the kenogrammatic pattern.

From such lack of structural differentiation resulted antinomies like those of Zeno of Elea, when he tried to reconcile the phenomena of Change and Motion with the static permanency of Being. The difference of Being and Becoming is equivalent to a difference between deuteron-structure and morphogrammatic structure. And this, in turn, requires the introduction of a third ontological locus and, consequently, a three-valued system.

Zeno's paradox stemmed from the fact that Being stands for the class of all ortho-objects designated by a single value. Time, on the other hand, belongs to the first class of pseudo-objects which require designation by a duality of values. When Zeno confronted Being and Time, he effected, formally speaking, a confrontation between value-singularity and value-duality.[10] It is obvious that no two-valued system can display all the features which Zeno's problem implies. The introduction of a third value is the first step to bring Time within the range of logical analysis.

The problem whether Time can or cannot be eliminated reveals itself now as a spurious alternative. Behind it looms the larger issue of two-valued classic and many-valued transclassic logic.[11] In Aristotelian logic, the progressive elimination of Time is, indeed, an inescapable postulate. It does not provide Time with an ontological locus of its own.

The kenogrammatic theory of logic offers such a locus; and thus Time is rendered non-eliminable. But the introduction of a third value and a concomitant ontological locus gives us only a new ontology - not yet a logic to think about it in terms of designation and non-designation. The theory of Time, therefore, requires a wider basis than three-place kenogrammatic structures provide. In order to illustrate this we introduce TABLE 3.

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[10] See also G. GUNTHER. 1964. Zweiwertigkeit, logische paradoxie und selbstreferierende reflexion. Zeitschrift für Philos. Forschung **17** (3): 419-437.

[11] The basic philosophic issue of the connection between many-valued logic and selfreference was first discussed by the author of the present paper in: Die philosophische Idee einer nicht-aristotelischen Logik. Proceedings of the XIth International Congress of Philosophy. Brussels, August 20-26, 1953. 5: 44-50.

TABLE 3 presents the pattern of designation for m-valued systems. The first vertical column on the left gives the total numbers of values for a given system. The double line, descending in ever increasing steps, separates designation from nondesignation. The numbers which appear on both sides of the double line do not represent individual values but give the sum of values required for a specified designative or nondesignative purpose. Where a zero appears, no value is available. The table starts with the one-valued system; and since a non-designative value is not available, such a system cannot properly be called a logic. It represents an ontology that provides a "theme" for a subsequent logic. The next step leads us to the two-valued system which is indeed a logic, since one-valued designation is here reflected in a non-designative value. These two systems make up the total formal structure of our traditional thinking; and as long as we are content with the simple contraposition of ontology and logic, we have no motive to go further. This elementary distinction corresponds to our formal differentiation between value-structure and kenogrammatic structure in general, with no kenogrammatic sub-distinctions. However, if we refused to pack Time into the ontological loci of Being and Thought, we learned that we had to proceed to at least a three-valued system. This step formally establishes the ontological difference between ortho-objects and pseudo-objects. Since we have found that the identification of Time as an ortho-object involves us in paradoxes, we may assume it to be a representative of the first class of pseudo-objects. On the other hand, a pseudo-object requires, as we noted, at least two values for designation- otherwise, there is no structural characteristic to set it apart from the ortho-objects. This leaves us no value for non-designation. In other words, a three-valued system is again no logic at all, but the formalization of a first transclassic ontology.

M	DESIG.	NON-DESIGNATIVE			
1	1	0			ONTOLOGY (MONO– THEMATIC)
2	1	1			| LOGIC
3	1	2	0		ONTOLOGY (POLY–THEMATIC)
4	1	2	1		| LOGIC
5	1	2	2		|
6	1	2	3	0	ONTOLOGY (POLY–THEMATIC)
7	1	2	3	1	|
8	1	2	3	2	| LOGIC
9	1	2	3	3	|
10	1	2	3	4	0
11	1	2	3	4	1
12	1	2	3	4	2
...	...	...	...	...	...

TABLE_3

Such an ontology implies two modes of designation: designation by a single value and also designation by a duality of values. Classic logic has only one ontological theme-Being as objective permanence. Thus, it is monothematic. All transclassic ontologies are poly-thematic. The classic ontology, represented by a single designative value, is retained in all transclassic ontologies; but to it, at least a second theme, represented by a duality of

values, is added. Only in the second theme does the problem of Time become fully accessible to formal logical procedure. In order to develop logical systems to correspond to the first poly-thematic ontology, we have to introduce non-designative values. This can only be done if we progress to a four and five-valued system. An ontology with two themes requires two successive systems of logic because its conceptualization has to choose between one or the other theme. Either the first or the second theme will shift into logical focus or, to put it in more formal terms, non-designation will either correspond to the, theme designated by the single value or it will reflect the second theme which needs a duality of values for designation. TABLE 3 shows these cases as four- and five-valued systems. The ontologically emphasized theme is indicated by underlining the appropriate numbers on the left side of the double line. What is not underlined is only carried along as a sub-theme. The two designational systems that follow the first poly-thematic ontology demand, of course, the introduction of a fourth and fifth ontological locus.

This prompts the question: What do these new ontological loci signify? The shortest possible answer is: Being, its reflection in Thought, and Time represent the whole range of objective existence as reflected in three-valued ontology. Yet there must be a subject of cognizance conscious of an objective world. This subject must be capable of distinguishing between the world as outlined in its ontology, its thought-image of this world, and itself as being the producer of the image. Since the first three loci refer to the world, the fourth locus must accommodate the image making and the fifth the producer of it.

At this point our departure from classic logic shows its most striking aspect. Our three-valued ontology encompasses Thought (as image) as a component of the environmental world. But as a process Thought occurs again in locus four. This reoccurrence is due to the inherent ambiguity of the term "Thought." It may either refer to the image, or the image-producing process. The classic tradition of formal logic neglects this ambiguity. And thus it does not understand the Janus-face of subjective self-reference. Subjectivity is both the still image of the world as well as the live process of making an image; and what we call a personal ego constitutes itself in the triadic relation between environment, image and image-making.

However, the act of self-reference which establishes the ego represents a detachment of the subject from the environment as well as from its own thoughts. The fifth ontological locus provides the place for it. The subjectivity which is aware of Being, Thought and Time is distributed over the loci which follow our three-valued ontology. The first four loci give us the full range of kenogrammatic distinctions. But something is still missing: the structural feature which indicates the detachment. Detachment by selfreference means, logically speaking, iteration or repetition. And this is just what the fifth ontological locus supplies. Five-place sequences add nothing to the distinctions between protostructure, deuterostructure and tritostructure; they only repeat them. Even the fact that only two kenograms are iteratable reoccurs.

The fourth ontological locus still adds to kenogrammatic differentiation. It does not represent repetition. Therefore, it does not signify complete detachment. The image-making it accomodates hovers in the twilight zone between solid objective existence and the evasive self- referential identity of the subject of cognizance. The fourth locus is the index of the inextricable enmeshment of the Mind with Reality through its own thoughts.

There is a passage in Shakespeare's Henry IV surprisingly applicable to our problem. Shakespeare calls the four ontological loci of the subject's entanglement with Reality: Thought, Life, World, and Time. He describes them as constituting what Warren S. McCulloch calls a heterarchical order - one in which the last link of the chain joins the first. Thus Time, the moving image of eternity, comes to rest when its flow enters the stillness of contemplative Thought. The dying Hotspur says:

> But Thought's the slave of Life, and Life Time's fool;
> And Time, that takes survey of all the World,
> Must have a stop.

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10. See also G. GÜNTHER. 1964. Zweiwertigkeit, Logische Paradoxie und selbstreferierende Reflexion. Zeitschrift für Philos. Forschung **17** (3): 419-437.

11. The basic philosophic issue of the connection between many-valued logic and selfreference was first discussed by the author of the present paper in: Die philosophische Idee einer nicht-aristotelischen Logik. Proceedings of the XIth International Congress of Philosophy. Brussels, August 20-26, 1953. **5**: 44-50.

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Gotthard Günther and Heinz von Foerster:

The Logical Structure of Evolution and Emanation *)

GOTTHARD GUNTHER: When I decided to accept Dr. Roland Fischer's generous invitation to read a paper at this conference I felt somewhat like a forger who passes on his counterfeit money to an unsuspecting public. It has been a time-honored tradition to say that logic and its laws are timeless and of eternal validity. This viewpoint has, of course, sometimes been subjected to a sceptical scrutiny, but all attempts to analyze time with the means of a logical calculus have come to nothing. Consequently, since the traditional viewpoint seems to be the correct one, it follows that a logician at a Time Conference should be a *persona non grata,* and the currency with which he pays for admission should not be acceptable.

However, I feel that my presence has some justification. The logic discussed in all previous confrontations between Logic and Time was invariably the classic two-valued logic; but it might be proper to raise the old issue again when a logician claims that our traditional theory of thinking is not the only one and that a trans-classic system of rationality might be able to tackle the problem of time if more powerful methods of investigation were available. Since the classic theory of rationality is indissolubly linked with the concept of value, first of all one has to show that the whole "value issue" covers the body of logic like a thin coat of paint. Scrape the paint off and you will discover an unsuspected system of structural forms and relations suggesting methods of thinking which surpass immeasurably all classic theories. This was the purpose of my paper "Time, Timeless Logic and Self-Referential Systems." The trans-classic order which we discover beyond the classic theory of logic was called "kenogrammatic structure."

However, there seemed to be some doubt as to how I arrived at that kenogrammatic concept, and limited time permitted no discussion of the transition from value to kenogram. Consequently, the quintessence of my procedure seems to require some detailed explanation. Such an explanation I have given in an earlier publication,[1] but, alas, only in strict logical terminology which may make it again difficult for an interdisciplinary audience to follow. In this dilemma, I turned to my colleague Heinz Von Foerster, a veteran in interdisciplinary meetings, to help out. He suggested that I present the development of these concepts in a mathematical vocabulary. But since this vocabulary is not my vehicle of mental propulsion, I let Von Foerster tell his story in his own words.

HEINZ VON FOERSTER: Perhaps the easiest way to see the emergence of the concept *Kenogram* is to see it through the concept of the "inverse" of a logical function. The inverse of a logical function is derived in precise analogy to the inverse of a mathematical function.

Let $y = f(x)$ be a mathematical function in which the "dependent" variable y is expressed in terms of the "independent" variable x, say $y = x^2$

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published in: Ann.N.Y.Acad.Sci. 138 (1967) 874-891

[1] GÜNTHER, G. 1963. Cybernetic ontology and transjunction operations. In Self-Organizing Systems: 313-392. Spartan Books. Washington, D. C.

with $f(x) = x^2$. Inversion is accomplished when the independent variable y is explicitly expressed in terms of the dependent x:

$$x = \varphi(y)$$

maintaining, however, the original functional relationship between the two variables. In the above example $y = x^2$, the inverse function is

$$x = \pm\sqrt{y}$$

Please note two points in connection with the inversion of functions. The first point refers to the conservation of the domain of x and the range of y before and after inversion. The second point refers to the possibility of a unique function becoming a multiple-valued function after inversion or vice versa.

Let me exercise these two points on the above example. If we wish to remain in the realm of real numbers, then in the expression $y = x^2$ the domain of the independent variable x is the set of all real numbers and the range of y, the dependent variable, is the set of all non-negative real numbers, while in the inverted form $x = \pm\sqrt{y}$ the domain of the independent variable, now y, is the set of all non-negative real numbers and the range of the dependent variable, now x, is the set of all real numbers. This is clearly seen if one wishes to use a negative real number as an argument in the inverted function. The result is a complex number, in contradiction to our premise to stay in the realm of real numbers.

The second point of the emergence of multiple valuedness after inversion is easily seen by the (+) and (-) sign in front of the square root. For y = 4, for instance, the inverse of $y = x^2$ produces indeed the two solutions $x_1 = + 2$ and $x_2 = - 2$ as suggested by the expression $x = \pm\sqrt{y}$ for $(+ 2)^2$ and $(-2)^2$ both equal to 4.

I turn now to the inversion of logical functions where, hopefully, it can be seen that Gunther's kenograms are nothing else but the original dependent variables becoming independent after inversion. Since the range of the dependent variable in logical functions is restricted to the number of values m in the logical system, e.g., m = 2 in a two-valued logical system, and since one deals here with logical systems that admit only a few values (i.e., m is a small integer), I believe it is quite legitimate to use simple geometrical forms, say triangles, squares, etc., for representing various variables, rather than the mathematician's x, y, z, etc. However, let me continue for a moment with the mathematical notation.

Let $X_n = \{x_0, x_1, x_2, \ldots, x_{n-1}\}$ be the independent variable in a logical function

$$y = F(X_n)$$

where X_n is represented by an n-tuple of independent elementary variables x_i ($i = 0 \rightarrow (n-1)$). The domain of these elementary variables x_i depends upon the choice of the valuedness of m of the logical system under consideration. In the classical two-valued system one has, of course, m = 2. Consequently, since the domain of x_i is m, the domain of the independent variable X_n is the set of all natural numbers between 0 and $(m^n - 1)$, i.e., comprises m^n values.

The *modus operandi* of a logical function is to associate with each of the m^n values of the independent variable precisely one value of the dependent variable y, the range of which is identical with the domain of the elementary variables x_i. A particular logical function is defined if for each of the m^n values of X_n a particular value for y within the range m is specified. This restriction produces a variety of precisely

$$m^{m^n}$$

different functions in an m-valued logical system with n independent elementary variables.

If I am not mistaken, in the history of the development of logical functions there exists nowhere a discrepancy in the terminology of "values" and "variables." These terms are used exactly in the sense as I used them before. However, a considerable variety in the use of *symbols* and in the *interpretation* of these symbols representing the "values" of these variables is to be noted.

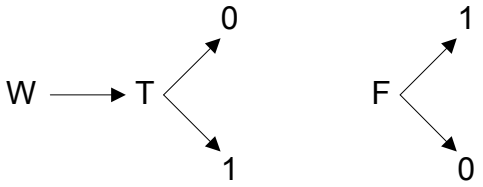
Let me stay, for the moment, within the classical case of a two-valued logic, i.e., m = 2. One will find the two available values being represented in a variety of ways, for instance W, F (for "wahr", "falsch"; Wittgenstein); or T, F (for "true", "false"; Russell); or 0, 1 (Boole, Hilbert); or 1, 2 (Günther), etc. This variety of symbolic representation of the variables leads, of course, to a variety of representations of one and the same logical function as I shall demonstrate on one particular logical function, namely, the logical "and" symbolized by "&," and also sometimes called the "logical sum" or the "logical product" (•) of the elementary variables x_0 and x_1.

x_1	x_0	&	x_1	x_0	&	x_1	x_0	•	x_1	x_0	+	x_1	x_0	
W	W	W	T	T	T	1	1	1	0	0	0	0	0	Δ
W	F	F	T	F	F	1	0	0	0	1	1	0	1	▼
F	W	F	F	T	F	0	1	0	1	0	1	1	0	▼
F	F	F	F	F	F	0	0	0	1	1	1	1	1	▼
	(i)			(ii)			(iii)			(iv)			(v)	

If (x_1) and (x_0) are interpreted as propositions, then it is clear that the representations (i) (ii) give the " truth- values" for the proposition "x_1 & x_0", for "x_1 and x_0" is only true (T, W) if and only if both x_1 and x_0 are true separately. Otherwise, "x_1 and x_0" is false (F). Representation (iii) makes use of the oddity that if "true" is represented by the integer "one" and "false" by "zero" then the truth-values for the logical "and" are obtained by algebraic multiplication $y = x_i \cdot x_0$. In (iv) the representations for "true" and "false" by the integers 1, 0 is reversed and the values for y are obtained by a pseudo- arithmetic addition in which 1 + 1 = 1. This latter interpretation of the integers 0, 1 has, however, the advantage that the logical function "inclusive or" can be represented as a proper algebraic product

$$y = x_1 \cdot x_0.$$

I apologize for this somewhat lengthy narrative on an otherwise well-known story. However, I wished to stress in this account the arbitrariness by which certain symbols may be associated with two-valued logical values "true," "false" or "position", "negation," etc. In the above examples, "true" was in one case associated with integer "one" and in the other case with integer "zero," and *mutatatis mutandis:*



With this introduction, I believe it is now easy to understand Günther´s mysterious triangles in example (v). Let the upright empty triangle stand for the integer 0 and the downward full triangle stand for the integer 1, then the function represented in example (iv) is obtained. If, moreover, T → 0 and F → 1, example (v) represents the logical function "&", which symbol may now be inserted into the yet empty space on top of the column representing y.

However, there is no need to insist on the interpretation suggested above, and we may as well reversely identify the upright empty triangle with the integer 1 and the other one with 0. But since this reversal does not affect the values of the independent variable x_2-a particular triangle is associated uniquely with a *set* of values of X_2, namely

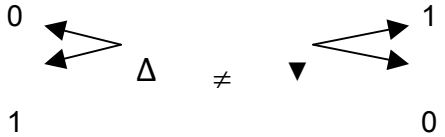
Δ = Δ (00)

▼ = ▼ (01; 10; 11)

such a reversal will alter the logical function:

X_2		M	Δ → 0 ▼ → 1	Δ → 1 ▼ → 0
x_1	x_0		x_1 & x_0	$\bar{x}_1 \vee \bar{x}_0$
0	0	Δ	0	1
0	1	▼	1	0
1	0	▼	1	0
1	1	▼	1	0

I hope that this simple example clarifies the meaning of those symbols that Günther called "Kenograms" and which are represented here as triangles of different shapes. Since kenograms may assume different values, but different kenograms not like values:



they may be considered to be "elementary variables" y_i of the dependent variable y, with the condition

$$y_i \neq y_j \qquad (j \neq i)$$

their range being the number of values m of the logical system. The indices i, j may assume values of the integers $1 \rightarrow r \leq m$, where r is the number of different values admitted to occur in the dependent variable. For example, r = 1 suggests that the dependent variable y admits only one value. For logical functions that are confined to two variables only (n = 2), this situation (r = 1) is given by the following scheme

x_1	x_0		T	C
0	0	Δ	0	1
0	1	Δ	0	1
1	0	Δ	0	1
1	1	Δ	0	1

in which by the particular sequence of like kenograms the logical functions C and T are represented which, in turn, may stand respectively for "Contradiction" and "Tautology," but only if "0" is associated with "true" and "1" with "false."

A particular sequence of kenograms has been called by Günther a "morphogram", M. However, such a "sequence" is not invariant to permutations of the sequential arrangement of the values of the independent variable X_n, The invariance of the association of a kenogram with a particular value of X_n, and hence the invariance of a morphogram with respect to permutations in a particular sequential arrangement of X_n can be established by defining the set of values X_{ni} which are associated with a particular kenogram:

$$X_{ni} = X_{ni}(\blacktriangledown)$$

To return to the previous example where the morphogram ΔV▼▼represented the two logical functions "&" and "$\overline{\&}$" we have:

$$(00) = \Phi_{\Delta}(\Delta)$$

$$(01, 10, 11) = \Phi_{\blacktriangledown}(\blacktriangledown)$$

or combined:

$$[(00); (01, 10, 11)] = \Phi(\Delta;\blacktriangledown)$$

which is, of course, nothing else but a representation of the set of the inverted logical functions "&" and "&":

$$[(00); (01, 10, 11)] = \Phi_1(0,1) = (\&)^{-1}$$

$$[(00); (01, 10, 11)] = \Phi_2(1,0) = (\overline{\&})^{-1}$$

From these remarks the general,, invariant, definition of a morphogram M can be deduced:

$$\left[X^1_{ni}; X^2_{nj}; X^3_{nk}; \ldots X^r_{nl}\right] = \Phi\left(y_1; y_2; y_3; \ldots y_r\right)$$

$$1 \le r \le m$$

$$(i \ne j \ne k \ne \ldots \ne \ell) = 1,2,\ldots m^n$$

Nevertheless, for practical reasons it is advantageous to stick to a standard sequential arrangement of the independent variable X_n which is most easily accomplished by associating with each combination of values $0 \rightarrow (m - 1)$ of the n elementary variables $x_0 \rightarrow x_{n-1}$ a digital number with basis m:

$$N = \sum_{0}^{n-1} x_i \; m^i$$

$$0 \le x_i \le (m-1)$$

and by ordering the sequence of kenograms in a morphogram according to ascending values of the independent variable

$$X_n = N = \{0 \rightarrow (m^n - 1)\}$$

If this convention is adopted, morphograms may be written as a sequence of symbols – the kenograms – whose position in this sequence uniquely defines the independent variable's value associated with this kenogram.

It may be useful to demonstrate this ordering principle by writing all morphograms that can be written in a two-valued logic (m = 2) constraint by two independent elementary variables x_0, x_1 (n = 2):

X_2

x_1	x_0	N
0	0	0
0	1	1
1	0	2
1	1	3

M

1	7						
Δ	▼	Δ	Δ	Δ	▼	▼	Δ
Δ	Δ	▼	Δ	Δ	▼	Δ	▼
Δ	Δ	Δ	▼	Δ	Δ	▼	▼
Δ	Δ	Δ	Δ	▼	Δ	Δ	Δ

The detached left table indicates the adopted sequence of values in the independent variable in binary form through x_0 and x_1 and in decimal representation, headed by N.

The right-hand table gives the various possible morphograms that admit at most two different values, with numbers at the top of the table (1, 7) indicating the number of morphograms that can be obtained when precisely one, or precisely two, different values are admitted to occur in a morphogram.

I believe that the quickest way to see how many morphograms can be written that admit precisely k values in a system that has n elementary variables and m values is to look again at the inverse representation of logical functions:

$$\left(X_{ni}^{j}\right) = \Phi_j(y)$$

$$j = 1 \rightarrow k$$

Since in such a system we have m^n distinguishable "objects," these are the different values of the variable X_n and k indistinguishable "cells" which represent the k inverse functions[*)] Φ_k, our problem is translated into the problem of finding the number of ways in which m^n distinct objects can be distributed into k cells, no cell empty. The answer to this question is, of course, a well known result in elementary combinatorics [2]. Let N(n, m, k) denote the number of morphograms that admit precisely k values in a system with n variables of m values, then

$$N(n,m,k) = S(m^n,k)$$

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*) The cells are indeed "indistinguishable," for it is irrelevant which particular value the argument y in these functions assumes. The only condition is that these values are *different* from each other.

[2] RIORDAN, J. 1958. Introduction to Combinatorial Analysis: 99. John Wiley & Sons. New York, N. Y.

where S(N, k) are the Stirling Numbers of the second kind[3]. The number of morphograms in such a system that admit at most k values, consequently is

$$N(n,m) = \sum_{i=1}^{k} S(m^n, i)$$

and those that admit the full range m of the value possibilities (k = m):

$$N(n,m) = \sum_{i=1}^{m} S(m^n, i)$$

If we restrict ourselves to two elementary variables (n = 2) we have

$$N(2,m) = \sum_{i=1}^{m} S(m^2, i)$$

the numbers of which are given below for the first four values of m:

m	N(2, m)
1	1
2	8
3	3281
4	178963355

Referring to the example given earlier, in the simple case of a two-valued logic, the number of morphograms is

$$N(2, 2) = S(4, 1) + S(4, 2) = 1 + 7 = 8$$

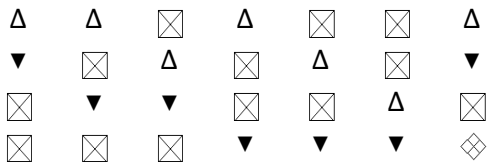
This appears to be a trivial result for this number can be directly obtained if one realizes that each morphogram admits only two interpretations, namely one function and its negation by replacing the values of "0" and "1" with their complements "1" and "0," respectively. Since there are only sixteen logical functions, half of which are the negations of the other half, the number of morphograms is clearly 16/2 = 8. However, I believe I am correct in saying that in general, for m > 2 and n > 2, a morphogram represents precisely all those functions which can be generated from one represenative function by a cascaded application of m-valued negators. In other words, a morphogram represents the logical structure of a particular function plus all its negations.

GOTTHARD GÜNTHER: Von Foerster is right: a morphogram represents indeed the logical pattern of an individual function together with all its proper negations. It is important to lay stress on the term "proper." During the first attempts to utilize many-valued systems of logic some ad hoc devices have been introduced which were improperly called "negations." We here abide by the traditional or classic concept of negation where negation is a symmetrical exchange relation between two values. If we have at our disposal a string of values m which belong to an m-valued logic, then we possess m - 1 independent negations Neg_i where each negation of a given value produces

[3] ANDREW, A. M. & H. VON FOERSTER. 1965. Table of the Stirling Numbers of the Second kind. Tech. Report No. 6, AF-OSR Grant 7-64, Electrical Engineering Research Laboratory, Engineering Experiment Station. University of Illinois, Urbana, Ill.

an exchange relation with the immediate successor-value. This yields the following generalized table of negations for m-valued systems:

M_t



It should be pointed out that it is quite irrelevant for kenogrammatic purposes which of the string of values that may be inserted into a morphogram is called positive and which is called negative. The only thing important in the present context is that a morphogram is a structural feature which remains invariant with regard to negational operations in traditional or many-valued logic.

But Von Foerster's analysis of kenogrammatic structure must elicit an additional comment: in connection with his table M, he speaks of an apparent triviality of the morphogrammatic concept. However, there seems to be another triviality hidden in the very same table. It contains only familiar structures, albeit we are told that if the white triangles are occupied by a given value, the black triangles permit only occupancy by a different value. It is unfortunate that in the special case of a two-valued logic the number of morphograms is exactly eight and the number of value sequences in a table for so-called binary truth functions is sixteen. This points to a symmetry of structure which has been frequently noted in the history of traditional logic. The apparent triviality of the concept of kenogrammatic structure, however, disappears if we notice that the detached right table uses only two kenogrammatic cases Δ and ▼ whereas the range of N is 0, 1, 2, 3. In other words: the detached right table is "morphogrammatically" incomplete. Its four-place sequences permit the introduction of two additional kenograms. They will be represented by two new symbols, a square ☒ and a diamond ⟐; and in order to indicate that they represent our entrance in trans-classic structures of logic we give them a common feature by putting diagonals in both. We are now able to complete table M by adding M_t

I call the sequences in the second table M, in order to indicate that they represent the trans-classic realm of the kenogrammatic system for the special case of four-place sequences. Both tables together constitute what has been called in the earlier paper "trito-structure".

Deutero-structure and proto-structure are then easily obtained by a process of "kenogrammatic abstraction." First, the actual location of a kenogram within a given sequence is deemed irrelevant. If one sticks to the paradigma of four-place sequences, the first abstraction yields five partitions within the trito-structure. I have visibly represented them in TABLE 2 of my formal paper read by arbitrarily choosing one morphogram of each class. The result of this abstraction was called deutero-structure. For the transition to proto-structure a different concept of abstraction was employed: in trito-structure as well as in deutero-structure, there are no limits for the iteration of a given kenogram. In proto-structure iteration will be permitted only for the purpose of completing the stipulated length of the morphograms. For this purpose the iteration of a solitary kenogram is sufficient. The individual shape of the kenogram that is chosen for iteration in order to make the structure "visible" is, of course, irrelevant.

Since our universe displays a temporal pattern, and logic is supposed to provide us with a rational description of the code of the universe, it is obvious that a computable connection between "timeless" logic and Time has to be established. However, since the computing

process of consciousness displays its own temporal features it is impossible to introduce time post festum into logic. Time can always be eliminated from all systems of logic whose very basis does not already involve structures amenable to a temporal interpretation. If Time is introduced post-natally, its features can always be substituted by features of logic of nontemporal character[4].

Since classic logic uses only two ontological loci, called in epistemology "subject" and "object," the paper on "Time, Timeless Logic and Self-Referential Systems" proposed a third ontological locus for Time to be incorporated in the very basis of logic. If we want to speak in the now rather obsolete language of values, this would call for a three-valued logic. But the introduction of a third kenogram leaves us with a morphogrammatically incomplete basis, since classic logic already uses four-place sequences. Thus, another kenogram was, required and my formal paper showed why we should be at liberty to introduce an indefinite number of kenograms.

The very purpose of our presentation of the kenogrammatic structure is to show value systems of logic so to speak in their pre-natal state from which logic emerges after values are introduced and are ready for insertion into individual kenograms. It was important to show that there is such nontrivial structure which is indifferent to negational operations, since negational operations belong to the very core of value systems. And in order to make a philosophic concept non-eliminable from value systems of logic, this very concept has to be introduced at a level where values are still irrelevant.

This we did with the concept of Time. It will now be our task to show that the kenogrammatic structure displays certain features which easily suggest temporal connotations.

It is obvious that the kenogrammatic structure may be analyzed in two different ways. We may either read TABLE 2 of my formal paper in a horizontal or in a vertical direction. In the first case we compare kenogrammatic sequences of equal length but of different structure; in the second case we compare shorter sequences of kenogrammatic symbols with longer ones. This leads to two logical concepts which can hardly be divorced from temporal connotations. Both concepts date back to a certain ambiguity in Plato's theory of Ideas, which led to the famous controversy between Xenocrates and Speusippos. Their common problem was the time structure of reality. We shall not delve into the subtleties of the debate. But from it two distinct ideas about the history of the universe have evolved.[5] One can either assume that at the Grand Beginning everything that later become actual appearance was already extant and the temporal process is nothing but an unfolding and gaining distinction of something which rested before Time began in the gray Neuter of a primordial substratum. The other assumption is that the multiplicity of things of the real world did not have a primordial pre-existence in some mysterious metaphysical essence but came into being only gradually by the development of more and more complex structures.

The first concept is called "emanative" and the second "evolutive." The controversy as to whether the history of the universe is to be considered as emanative or an evolutive process is as old as the history of science, and the controversial arguments seem to be far

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[4] This has been shown for a very important instance by W. S. McCulloch and W. Pitts by their derivation of a "temporal propositional expression" in which Time does not appear explicitly, but where sequential order is provided by an iteratively employed operator S. (1943. A logical calculus of the ideas immanent in nervous activity. Bull. Math. Biophys. 5: 115.)

[5] Cf. W. WINDELBAND. 1928. Lehrbuch der Geschichte der Philosophie. : 203. Verlag J. C. B. Mohr. Tübingen, Germany

from exhausted. Some thinkers have suspected that what we might call the time structure of the universe is a compromise between emanative and evolutive principles. But their arguments have never been convincing, because they were defeated by the logical complexity of their problem.

Since the terms "emanation" and "evolution" were never well defined in formal logical terms, it was a hopeless task to try to understand the history of the universe as an interplay of an emanative and an evolutive component.

We shall have no pre-conceived ideas about evolution and emanation. We merely stipulate that we shall call the logical relations and concepts which arise from the comparison of kenogrammatic sequences of equal length "emanative" and those that the comparison of kenogrammatic symbol sequences of non-equal length yields "evolutive." If it happens that some of our statements about both time structures agree with the statements of the philosophers of history, we shall consider this a pleasing and gratifying coincidence. But as far as they do not agree, we like to point out that we do not consider emanation and evolution as mysterious processes with properties per se. Exactly the contrary is the case. We stipulate certain properties and say afterwards: This is what we call "emanation," and that is what we call "evolution." In fact, we have already done so by labeling the relations between shorter and longer kenogrammatic symbol sequences "evolutive," and the relation emerging from the horizontal order of sequences of equal length "emanative."

We shall confine ourselves here to discussing one issue that is closely linked to the controversy about emanation and evolution. The issue centers in the much debated question: Is the temporal process of the universe goal-directed or not? We know from our experience that certain systems in the universe display a goal-directed behavior but others do not. But what about the universe as a whole? The question is not merely metaphysical. It is of practical importance for the understanding of the behavior of living systems.

To obtain an answer to this question, we shall first investigate the "vertical" relations between shorter and longer kenongrammatic sequences. We shall use the method of mapping and intend to demonstrate it within the vertical relations of deutero-structure. If we map every kenogrammatic sequence unto itself, we shall find that such a mapping process either yields the same kenogram or one of shorter length. What cannot be done is to map a kenogrammatic sequence unto itself in such a way that a shorter kenogrammatic sequence may produce one of greater length.

In order to show the method in some detail we introduce two new concepts which we may call "monomorphy" and "kenogrammatic equivalence."[6] A monomorphy is the set of all iterations of an individual kenogram. The boundary case of such monomorphy is a single kenogram. It is irrelevant whether a monomorphy is interrupted by one or more kenograms of different shape. It is only for the purpose of a simpler demonstration that we are going to write our monomorphies below in uninterrupted sequences.

Two kenogrammatic sequences are keno grammatically equivalent if they show the same structure but different kenogrammatic symbols are used. Thus, the sequences ΔΔ▼ and ▼▼Δ are equivalent. However, the sequence Δ▼ ☒ is not equivalent with the two preceding ones.

Since our mapping process, although permitting the interruption of a monomorphy, does not allow its breaking up for mapping purposes, we find that the five kenogrammatic sequences with four places represent the preceding shorter sequences in a way which is shown diagrammatically in the following table:

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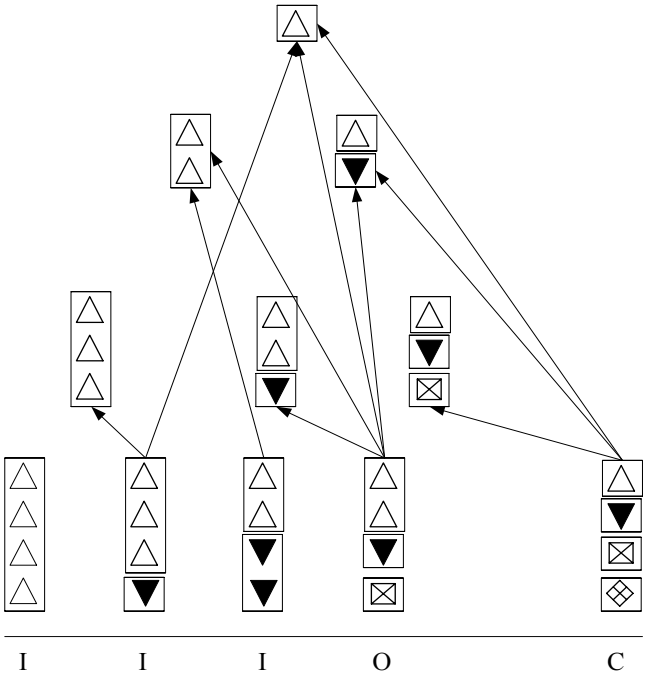
[6] For the concept of "kenogrammatic equivalence" I am indebted to Mr. Dieter Schadach.



Inspection of this table shows that the monomorphy with four places, if mapped unto itself represents only itself. The next sequence exists of a threeplace and a one-place monomorphy. The arrow points to the three-place and one-place sequences which results from the respective mapping processes. The reader should not be confused by the fact that the one-place monomorphy at the bottom contains a dark triangle and the one at the top a white triangle. Both are kenogrammatically equivalent and this is what counts. The third kenogrammatic sequence at the bottom is composed of two two-place mono-morphies. Owing to their equivalence both represent the monomorphy to which the arrow points. The next kenogrammatic sequence at the bottom is formed by a two-place monomorphy and two monomorphies of once place. This permits a much wider representation by the mapping process as is seen in the diagram. We remark, incidentally, that equivalent monomorphies are always shown with one set of symbols only. The choice of the symbols is principally free, but since we use in two-place sequences only triangles, the image of the sequence ▼ ☒ is represented by Δ▼.

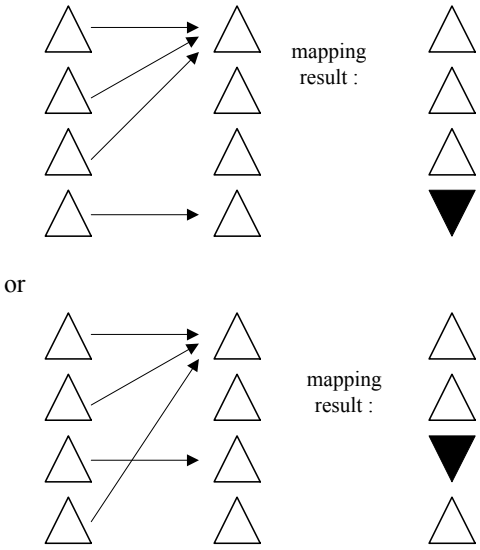
The last kenogrammatic sequence is composed of four one-place monomorphies. It may, of course, be mapped unto itself in such a way that either one or two or three monomorphies are eliminated. Thus, this four-place sequence like the preceding represents three-place, two-place and one-place sequences.

The letters I, O, C at the bottom of this diagram represent the terms "Incomplete," "Overcomplete" and "Complete". If a four-place sequence does not represent all preceding lengths of sequences, the representation is said to be "incomplete"; if it represents all preceding lengths but any given length in more than one way, it is called "overcomplete"; and if it shows for each length one example of representation it is "complete." It should be noted that this classification of the demonstrated mapping capacities is not exhaustive. In order to make it so, we have to assume another case which shall be called " paracomplete." A representation is said to be para-complete not if all preceding lengths of kenogrammatic sequences are representable by the mapping process, but rather if a given length could be represented twice. This case, which makes these representational distinctions exhaustive, however, occurs only if kenogrammatic sequences with eight places are introduced.

One should be aware of the mapping relations being unidirectional. The four-place sequences are, in our case, the domain of the mapping procedure and the shorter sequences represent its range, but not vice versa. It follows that, as far as the history of the universe is exclusively governed by evolutive principles, the future is unpredictable. And it is unpredictable for purely logical reasons; in other words, it is not empirical unpredictability, which may be removed by sufficient accumulation of data-it is an a priori unpredictability. The evolutive structure permits only a look into the past. In this context we may recall that Plato says all knowledge is recollection (anamnesis).

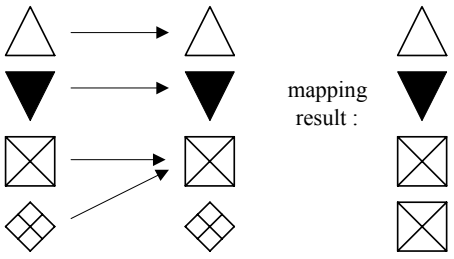
Considering its logical structure we cannot assume the evolutive process to be goal-directed. It tends towards greater and greater diversity without an ultimate principle of integration.

Now we turn our attention to what I have called the emanative structure. I shall use for demonstration the trito-structure with kenogrammatic sequences of four places. The very same concept of mapping will be applied. But since this operation is now concerned with relations between symbol sequences of equal length, the mapping procedure demands that monomorphies may be split up. Two examples shall illustrate the idea.



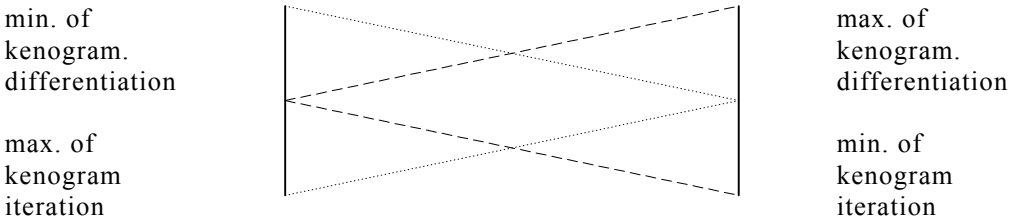
A morphogram iterating a single kenogram over all four places is mapped onto itself. The arrows indicate the mapping method. The results show in both cases that the four-place monomorphy is broken up into a three-place and a one-place monomorphy. It stands to reason that several mapping procedures are available to obtain the very same result.

Starting from the opposite end of the trito-grammatic structure we might start the mapping as follows :



In the past example, a morphogram with four one-place monomorphies is also mapped onto itself; the mapping method is again indicated by the arrows. This yields, as we see, again a four-place morphogram which consists of two one-place and one two-place monomorphies.

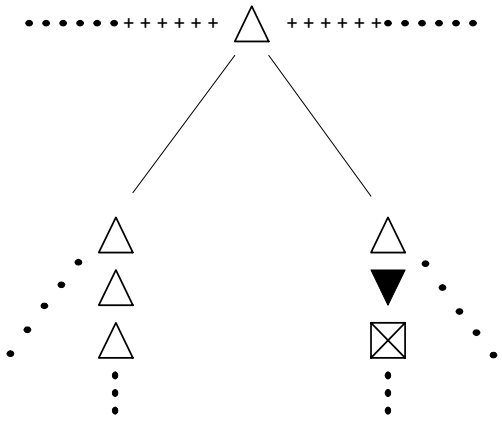
The examples show that this time the mapping process can be applied in both directions. If we proceed from left to right the kenogrammatic iterations decrease from four places to one. But while this happens, the number of kenograms increases. If we proceed from the right to the left, the number of kenograms decreases, but the iterative capacity of the remaining kenograms increases. Displayed in a diagrammatic form, the pattern looks as shown on the next page.



The dotted line represents the decrease, or increase of iteration; the dahsed line the corresponding increase or decrease of kenogrammatic differentiation. Since the mapping process permits a start from the maximum of iteration as well as from the maximum of differentiation, the emanative process is-judged by purely logical principles- predictable. Moreover, whereas the evolutive process (which may be demonstrated either with proto-, deutero- or trito-structure) is only one, there are many emanative processes as we can count logical stages of evolution. The emanative processes are always finite, but they are of different length. Their length depends on how many iterations are permitted for a solitary kenogram.

It is interesting to note that medieval philosophy decidedly preferred the emanative pattern of world history. Since the history of the universe begins with the creation (and Paradise Lost) and develops towards the Last Judgment (and Paradise Regained), this temporal process is finite as well as goal-directed.

If we want to draw a corresponding pattern for evolution as we did for emanation, it would have the following shape:

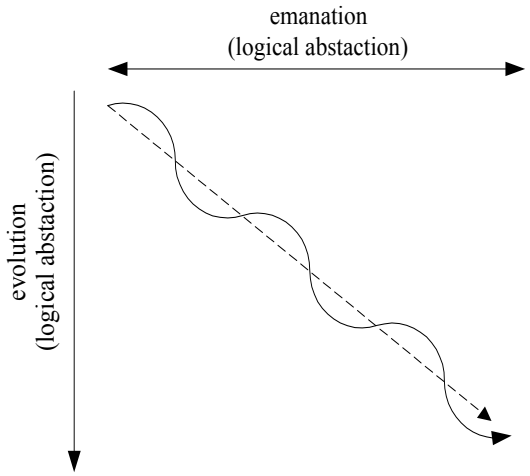


The horizontal line of crosses extending into infinity in both directions represents the unlimited potentiality for extensional structure. But out of the infinity of available starting points (+) for evolution, one individual ontological locus (Δ) is singled out: the logical pattern begins with a solitary kenogram. From here the structure gradually broadens out into a potentially infinite diversity. But the later logical structures are not contained in the solitary kenograrn which represents the beginning. They are a result of structural relations

generated by the subsequent diversity. In other words, the philosophical category of the "New" is germane to the evolutive pattern of thinking.

On the other hand, there can be nothing new in a process which follows solely emanative principles of development. For the emanative thinkers the history of the universe is a gradual appearance of what there already is. John Scotus Eriugena (810-877 A.D.) describes the universe as a theophany, i.e., a revelation of God during the progress of Time.

The modern thinker dealing with temporal structures is, of course, preponderantly interested in the issue of scientific predictability. We have noted that the evolutive pattern excludes predictability a priori. The emanative pattern not only permits predictability, it even implies it logically. But since everybody knows that in our world certain events are predictable, the temporal process of our universe must actually be a compromise between evolutive and emanative laws. The following diagram sketches the actual temporal process of our universe as an ideal compromise. It is, however, highly improbable that such an ideal compromise takes place in our real world. Our scientific data rather suggest that either emanative or evolutive trends may dominate.



If we call logical systems which are proponderantly dominated by emanative structures "overbalanced," systems of an ideal compromise "balanced," and systems where evolutive patterns outweigh emanative structures "underbalanced"[7] then the actual Time structure of the world we live in must be probably described by a sequence of systems which weaves incessantly from underbalanced systems to overbalanced systems and back. This, of course, implies that Time structure is influenced by the events which take place "in" Time. The popular concept of Time, where Time is visualized as a sort of clothesline extended from infinity to infinity, independent of whether the housewife clamps on her laundry or not, has been proved inadequate long ago. But so far no serious attempt has been made to connect Time with the *complementarity* of evolutive and emanative structures. If we use only twovalued logic with its two corresponding kenograms, this complementarity displays only trivial properties. The classic, two-valued logic is not an adequate tool for the problem discussed above.

[7] For a more detailed account on the distinction between overbalanced, balanced and underbalanced systems of logic see G. Günther. 1963. "Das Bewusstsein der Maschinen": 177f. AGIS Verlag, Baden-Baden, Germany. It should be added, however, that loc. cit. the distinction was only applied to logical systems with values. (a new edition of "Das Bewusstsein…" was printed in 2002).

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The Tradition of Logic and the Concept of a Trans-Classical Rationality

by Gotthard Günther [*]

Nobody can seriously doubt that the development of logic has made enormous strides forward during the last century. This is mostly due to the close alliance which has taken place during that period between this once purely philosophical discipline and modern mathematical methods. Both sides have gained from this union. Especially logic! Its progress has since been phenomenal. However, it will pay to have a critical look at these modern advances and find out what has been gained and in which direction no progress has been made at all. Because, as we will show, there is a field where logic still stagnates as much as it did at the time when Kant made his famous complaint about it in the preface to the second edition of the Critique of Pure Reason.

Let us first have a look at the gains and determine what is their common feature. When, about the middle of the 19th century, mathematicians started to have a closer look at logic they were confronted with a well established formal "system" (with a minimum of symbolism) which dated back to the Organon of Aristotle and to some fundamental concepts first expounded in the dialogues of Plato. A more intimate investigation during the following decades showed that this logical tradition represented anything but a completed and satisfactory system. It could at best be called the fragment of a formal logic. It was incomplete even within its own narrow limits. It lacked sufficient formalization and its operational principles were not well enough defined. Moreover, many procedures which play a dominant part in modern logic were not even discovered. Under the circumstances one is rather tempted to say – with not too much exaggeration –: what the tradition had handed down was just the program or the idea of a formal logic but not the thing itself.

It is obvious that, since the preliminary investigations of De Morgan, Boole and others, the time up to our present day was well filled with implementing this program which the classical Greek thinkers and the medieval tradition had set up for us. The advances made since logic was really developed within the new medium of abstract calculi are so overwhelming that it would take a heavy volume to recount them in detail. It is not necessary anyhow. The professional logician knows them well enough. There is, however, a common feature which all these, new discoveries share – a feature which is rarely in the conscious mind of the practicing logician –: whatever has been accomplished in the modern "revolution" of logic is nothing but the conscientious fulfillment of a plan or program that was conceived and formulated in the hey days of

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classical Greek philosophy. At that ancient time it was mostly expressed by means of mythological or metaphysical concepts. Today we are trying to execute the very same program in purely formal and mathematical terms. In other words: no matter how far advanced and how variegated our modern techniques of logic may be they still hail back to the same ancient metaphysical background.

This implies that the very last philosophical foundations of our logical tradition are neither seriously discussed nor radically questioned. One takes them for granted.

The author of these reflections confesses that he had to muster up some courage to make this statement. All appearances seem to refute him. Do not the schools of Logicism, Formalism and Intuitionism prove by their very existence how intensely the philosophic foundations of modern logic are debated! Is not the deep rift between logical Platonism and Constructionism proof enough that the most basic issues are at stake! Of course, nobody can deny that philosophical controversies are involved in the development of modern calculi. But – and this is our point – they take place only within the confines of classical Rationality. And if the arguments sometimes become so aggressive that recently an outstanding logician had to point out the need for tolerance[1] one has to stress the undeniable fact that all these intensive debates and sharp controversies only prove how fanatically all the participants believe in the problem they are trying to solve.

There is a deep and lasting agreement between all modern schools of logic and an almost fanatical consensus that what the tradition has handed down to us as "the" problem of logic is the only problem indeed.

It will be useful to examine this sacrosanct tradition. One can summarize it in the following three "dogmas":

1. the dichotomy of form and matter is relevant for any system of pure logic.
2. the concept <object> is non-ambiguous.
3. the semantic relation between Truth... Falsity (including a scale of intermediate terms) and logical values is unique.

The interdependence of these three tenets is obvious and equally clear is that only a two-valued type of logic can satisfy them all. This accounts for the vacillating attitudes logicians have taken toward the problem of a many-valued logic. The initial enthusiasm with which many-valued systems were tackled when they first came up in 1920 has gradually waned[2]. In philosophical logic the animosity against these systems has been almost unanimous, using the unrefutable argument that the principle of many-valuedness violates the classical concept of truth[3]. And it is interesting to note

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1 Cf. Heinrich Scholz und Gisbert Hasenjaeger, *Grundzüge der mathematischen Logik*, 1961, p. 11f.

2 I.M. Bochenski, "Die Fachlogistiker, die einst diese Systeme mit Enthusiasmus begrüsst haben, stehen ihnen heute zum grössten Teil sehr skeptisch gegenüber". *Der sowjet-russische dialektische Materialismus*, 1956, p. 132.

3 Cf. Paul F. Linke, *Die mehrwertigen Logiken und das Wahrheitsproblem*, Ztschr. f. Philos. III (1948) p. 378 ff. and p. 530 ff. Also: B. v. Freytag-Löringhoff, Logik, 1955, p. 177 ff.

that already in 1932 a scholar who is equally at home in philosophic as in symbolic logic declared with reference to many valued theories: "The attempt to include all modes of classification, and all resultant principles, would produce, not a canon, but chaos". [4]

This was written 30 years ago and it cannot be said that the situation has improved since. We shall cite only one more witness for the most recent time with the statement: Bei "Einführung von mehr als zwei Wahrheitswerten … gelangt man, sofern man sie wirklich als *Wahrheitsmodi* auffassen will, zu offenbaren Aporien der Interpretation, die sich auf keine zwanglose Weise überbrücken lassen. [5]

This is the point where, despite the rapid advances during the last century, an area of stagnation is still visible within the domain of logic. The stubborn adherence to the three philosophic "dogmas" of classic tradition, and the consequent obsession with the idea that any logical value of any system whatsoever must be interpreted as a truth value, has blinded scholars in the realm of logic to the fact that the acceptance of many-valued procedures constitutes an actual defection from the classic basis of scientific thought. In view of the fact that quantum mechanics has also departed from this basis[6] it seems natural that logic should not put the clock back nor refrain from sailing further into the treacherous waters of many-valuedness. But if this venture is really undertaken that last pool of stagnation in logic must be finally stirred up by a thorough investigation into the limits of the generality of our three classic "dogmas" of logic.

Since 1953 this author has tried to make a start in this direction with a series of publications[7] all of which attempt to deal with the proposition that the so far uncontested classic definition of logic should be abandoned in favor of a broader one. As philosophical maxims for this new trans-classic logic we suggest:

1a. the dichotomy of form and matter does not hold in n-valued systems where n>2.

2a. the concept of 'object' is amphibolic[8] when n>2.

3a. the disjunction truth/falsity applies as value designation if and only if n=2.

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4 C. I. Lewis, *Alternative Systems of Logic*, The Monist XLII, 4 (1932), p. 507.

5 H. Arnold Schmidt, *Mathematische Gesetze der Logik* I, (1960), p. 125, also p. 370 ff.

6 The half-hearted attempt of Hans Reichenbach (Philosophic Foundations of Quantum Mechanics, 1946) to demonstrate this departure logically could not really succeed because he was not able to rid himself of the classic prejudice that 'logical value' and 'truth value' are synonymous.

7 *Die philosophische Idee einer nicht-aristotelischen Logik*, X1. Int. Congr. Philos., Brussel (1953), V; p. 44-50 – *Dreiwertige Logik und die Heisenbergsche Unbestimmtheitsrelation*, Int. Congr. Philos. of Science, Zürich (1954), II; p. 53-59. – *Metaphysik, Logik und die Theorie der Reflexion*, Arch. Philos. (1957), VII., 1/2; p. 1-44 – *Die Aristotelische Logik des Seins und die nicht-Aristotelische Logik der Reflexion*, Ztschr. f. Philos. Forsch. (1958), XII, 3; p. 360-407 – *Ein Vorbericht über die generalisierte Stellenwerttheorie der Logik*, Grundlagenstudien aus Kybernetik und Geisteswissenschaft (1960), I, 4; p. 99-104.

8 Cf. I. Kant., *Die Kritik der reinen Vernunft*. B, 316 ff. (Von der Amphibolie der Reflexionsbegriffe).

In the first volume of his "Idee und Grundriss einer nicht-Aristotelischen Logik" (1959) this author has endeavored to outline the historic antecedents and to develop – on a purely philosophic basis – the systematic concept of a field of genuine trans-classic rationality. There are abundant historic antedecents in Kant (his Transzendentale Dialektik) Fichte, Hegel and Schelling, and since they all converge in that enigmatic product which Hegel calls "Logik" it seemed advisable to concentrate on him. However, that should not be construed as an attempt to vindicate the "spekulative Logik" in the eyes of modern symbolic Logic or even to amalgamate the two. This is clearly impossible. On the other hand: there can be no doubt that the Deutsche Idealismus has discovered a new systematic problem for Logic! It is the phenomenon of self-reflection. Kant, Fichte, Hegel and Schelling have stoutly maintained that this phenomenon, although "logical", is not capable of formalization.

It is the main thesis of "Idee und Grundriss..." that the datum of self-reflection (consciousness) is fully amenable to formalization. The resulting calculus would be the backbone of the New Logic. Its basis would be represented by the trans-classical maxims, la, 2a and 3a containing the classis tenets 1, 2, 3 as the ontologic subsystem. This author is convinced that many propositions of Hegel's logic would lend themselves to treatment within a calculus[9]. However, in view of the main goal this is incidental and it would be the business of the mathematician but not that of the philosopher!

The phenomenon of reflection has, of course, always played its part in symbolic calculi. Yet no formal criterion for self-reflection has been discovered. We see the nearest approach to it in the theory of Intuitionism. The emphasis on construction is a sort of self-reflection which the more traditional methods lack. But here too the tenacious adherence to the idea of equating value and truth-value has impeded the final deliverance from the Greek Tradition. Thus – in the principal philosophic sense in which we use the term – Intuitionism still belongs to classic mathematics! It follows that many statements that mathematicians make about intuitionistic procedures cannot be accepted at their face value.

The crux of the matter is, of course, the question: what is self-reflection and why can its laws not be developed in two-valued logic? Let us first tackle the semantic side of the question. With the alternative: is this true or false, we miss the whole point of the problem. Because as soon as we begin to talk about self-reflection we have ceased to refer to the original classic situation where a thinking subject naively (= without reference to itself) faces a universe of (thought) objects. Instead of it we want to know: what laws of reflection govern the opposition between Subject and Object? It is easy to see where the fundamental difference between classic and trans-classic theory of thought lies. The first, not referring to the subject of reflection, uses reflectional structures exclusively for the description of objects in the most general sense of the term. The second refers expressly to the phenomenon of subjectivity and investigates the tripartite division between individual subject, general subjectivity and object. This obviously calls for a three-valued formal system. Its advantages for a theory of reflection are clear. It can, provide us with a formalized language that permits us to

9 Cf. A. Speiser, *Elemente der Philosophie und der Mathematik*, 1952, Esp. from p. 83 on.

treat a term as subjective as well as objective reflection in the very same context. In the classic system it was always an exclusive either-or. But this conjunction of Object and Subject is exactly what confronts us in the world that surrounds us. As everybody knows, it is not made up of bona fide objects alone but also of subjects which are, like everyone's own ego, centers of reflection and claim to be treated as such. From a logical point of view, however, they are to me theoretical objects of thought. In other words: subjectivity is a phenomenon that appears in distributed as well as in non-distributed form. In its non-distributed form we call it an individual subject. If it is in distribution we refer to it as the intersubjective medium of general subjectivity. In contrast to it: the objectivity of an object is never distributed. The isolated object is fully identical with itself. For a subject this is an unattainable ideal. In its non-distributed form it is merely our thought-object and not a subject in its own right.

It should now be understood if we say that the classic, two-valued logic describes our system of formal rationality as an undistributed order of concepts. This is done by vigorously excluding any reference to the thinking subject[10]. Or – to express the same fact in syntactical terms – by permitting just one negational operator as a means to establish a symmetrical exchange relation between two values. This leads to, the famous *coincidentia oppositorum* of Nicolas Cusanus as Reinhold Baer has pointed out[11]. Apart from earlier philosophical attempts it has so far been mostly L. E. J. Brouwer's criticism of the Tertium non datur which can be taken as a symptom that the need for a distributed system of rationality was more or less clearly felt. However, it seems that Intuitionism does not go far enough. The principle of distribution should not only affect the Tertium non datur but Contradiction and Identity as well. This can only take place in a genuine many-valued system and Intuitionism is not such a system.[12]

There seems to be only one way to effect a consistent distribution of rationality for Identity as well as for Contradiction and Tertium non datur, namely, the introduction of a general m-valued system where m > 2. But our proposal differs fundamentally from all previous attempts. Instead of interpreting a many-valued system as a true-false theory with an intermediate sequence of indeterminacies or modalities we declare any m-valued logic to be a place-value system of all subsystems of the value order m-1, m-2, m-3, m-n, such that m-n = 2. It can be easily seen that a three-valued logic provides three "places" for the classical two-valued logic, because the latter is represented in the larger order by the subsystems 1↔2, 2↔3, and 1↔3.[13] Similarly a four-valued logic offers 6 places for two-valued and 4 places for three-valued

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10 This is what E. Schrödinger calls "the principle of objectivation" which demands that "we exclude the Subject of Cognizance from the domain of nature that we endeavour to understand," *Mind and Matter*, 1958, p. 38.

11 Reinhold Baer, *Hegel und die Mathematik*, In: Verhandlung. d. 2. Hegelkongresses v. 18-21. X. 1931. Ed. B. Wigersma, Tüb. 1932.

12 This was stated only recently by H. Arnold Schmidt who remarked "dass die intuitionistische Logik überhaupt keine ´mehrwertige´ Logik ist!" *Mathematische Gesetze der Logik* 1,(1960), p. 370.

13 More relevant details are given in the following publications of the author: "*Die Aristotelische Logik des Seins und die nicht-Aristotelische Logik der Reflexion*", and also in the "Vorbericht", Cf. footnote 7.

sub-systems. Generally speaking, the numbers of all possible subsystems of any m-valued structure are identical with the corresponding numbers in the Table of Binomial Coefficients.[14]

It stands to reason that no m-valued structure (m>2) that is interpreted as a logical place-value system can be used in the classical truth functional sense. Since the very same two-valued logic may turn up in any number of places, and since nobody will sincerely subscribe to the "atrocious monstrosity" (Schrödinger) of a roof-mind having an indefinite number of sub-minds which semi-independently judge statements as true or false, the only natural solution is to understand these larger systems as inter-subjective patterns of reflection that distribute our unique, classic two-valued logic over the total range of Object and Subject. It is absurd to assume that any individual consciousness could ever manifest itself in anything but a two-valued logic. In this sense the classic system of thought is archetypal and canonical! But if any thinking subject faces the world it discovers that its environment displays this very same logic in a wide (possibly infinite) pattern of distribution. This pattern possesses a primordial polarity: the opposition of the I and the It. But since the Universe for any given center of thought (scil. subject) contains not only bona fide objects but other centers of thought (scil. objective subjects) too, the reflectional pattern of our archetypal logic is distributed over all these centers.

The classic Tradition has ignored this fact as far as formal logic was concerned. It has done so with very good reason. Because as long as the pure and undiluted objective character of the Universe – which is faced by all thinking subjects alike – seems to be the sole theme of theoretical thought there is no problem about the inter-subjective generality of our conceptual terms. It is evident that, if any two subjects A and B agree about a given object O they also agree with each other. Consequently A, B and any other subject C that is in the same position can be treated as a single logical subject. The result is the absolute dichotomy of subject and object to which the two-valued system precisely corresponds. It all boils down to the time-hallowed concept of a universal, absolute (divine?) Self into which all individual minds merge if they think in strict logical terms. It is obvious that, if subjectivity, qua subjectivity, plays any part at all in this logic it does so only in its non-distributed form… having one, solitary center of reflection. It should be equally obvious, that, if computer-theory aims at defining a mind in rigidly objective terms, our classic Tradition is principally insufficient. Or shall we assume that an automaton that is catching up with us in handling problems of logic also undergoes a mysterious merging into an absolute Subject? This is absurd if not blasphemous.

Ergo, we have no choice but to assume that, if the bona fide object also handles formal logic and establishes theoretical agreement with us (or we with it), inter-subjective communication which "transcends" the shell of the isolated individual self is based on a distributed system of Rationality where the very same logic may be activated (as a complete system) in a minimum of three ontological "places": (1) in the individual isolated subject as apart from the world; (2) in the isolated object. And (3) in a system that describes the difference between (1) and (2). A three-valued logic fulfills these

14 I am indebted to Professor Heinz von Foerster (University of Illinois) for having drawn my attention to this fact.

minimum requirements. But since there is more than one individual subject in the Universe the subsequent introduction of higher valued systems is also required. They all serve the same purpose: to distribute our unique classic order of two-valued rationality over larger and larger place-value systems. Their infinite order implements the concept of a trans-classical (non-Aristotelian) rationality. The rationality of Reflection which embraces that of Being.

To sum it up: A non-Aristotelian or trans-classical logic is a system of distributed rationality. Our traditional (two-valued) logic presents human rationality in a non-distributed form. This means: the tradition recognizes only one single universal subject as the carrier of logical operations. A non-Aristotelian logic, however, takes into account the fact that subjectivity is ontologically distributed over a plurality of subject-centers. And since each of them is entitled to be the subject of logic human rationality must also be represented in a distributed form. The means to do this is to interpret many-valued structures as place-value systems of our two-valued logic. In any m-valued logic our classical system is distributed over $\frac{m^2 - m}{2}$ places.

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Gotthard Günther [*]

Cybernetics and the Dialectic Materialism of Marx and Lenin

Motto: One cannot completely understand Marx' *Kapital* and especially the first chapter unless one has studied and digested the whole logic of Hegel.

Vladimir Ilyich (Ulyanov) Lenin

The development of cybernetics in the Soviet Union and other Marxist countries has recently [0] become a subject of considerable interest to scientists and – to a lesser degree – to politician in the United States. An increasing number of reports and publications – some of them however only accessible to a limited circle of readers – testifies to this fact.

This interest covers so far almost exclusively the technical advances which have been made by scientists beyond the Iron Curtain and there is also some curiosity about the impact cybernetics has made on industry and social life. What Western observers have so far neglected to analyze is the amazingly and strong influence cybernetic theories are having on Communist ideology and on its philosophic basis, a fundamental ontology called: dialectic materialism. [1]

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* This essay is an enlarged representation of a lecture the author did deliver at the University of Cologne (Köln, Germany) July 17, 1964. Several passages of little interest to the American reader have been deleted.

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0 Note_vgo: 'recently' refers to the early Sixties of the 20th century.

1 Friedrich Engels is very frequently considered the founder of dialectic materialism and Marx the originator of historical materialism. This is not quite true although a not inconsiderable number of textbooks on the history of modern philosophy voice such opinion. First, dialectic materialism is already an intrinsic part of Hegel's philosophy as Lenin correctly pointed out and when Marx inverted the ontology of the Great Logic (Grosse Logik) he inevitably turned dialectic idealism into an equally dialectic materialism. Second, dialectic materialism is also implied in Fichte's "Bildtheorie" (theory of transcendental reflection) when he maintains that subjectivity is a fictitious capacity. The statment: < I think > is according to him downright false. One is only permitted to say: "there is thinking". (II, p. 244) Walter Schulz who quoted this passage in his "J. G. Fichte Vernunft und Freiheit" (Pfullingen 1962, p. 16 ff.) adds that the concept of an absolute Self is in Fichte's theory of reflection in the grave danger to dissolve it self ("...wesenhaft in der Gefahr steht, sich überhaupt aufzulösen.") But if this happens then there is nothing left but dialectic materialism and the transcendental theory of reflection. The decisive step from "idealism" to dialectic materialism was prepared by L. Feuerbach but actually executed by Marx (cf. W. von Aster, Geschichte der Philosophie (1935) p. 364.) Fr. Engels collaborated to explicate the theory further.

There is scant interest in the United States for dialectic materialism. Owing to prejudices and lack of adequate knowledge about the development of transcendental logic from Kant via Fichte to Hegel, Marx' philosophic theory is mostly judged to be nothing but an ideological edifice to be used as tool to further political aims. Dialectic materialism has allegedly been conceived for the very purpose of overcoming the spiritual tradition of the Western World and its concomitant organization of human society. It is true that dialectic materialism has been used as a tool by one of the most powerful political movements in history but it is ludicrous to believe that it has been "invented" only to serve extraneous economic or social forces. The development of transcendental logic beginning with the *Critique of Pure Reason* (esp. with Kant's 'Transzendentale Dialektik') and attaining its culmination in Hegel's 'Großer Logik' had clearly shown that all traditional categories of ontology were in great need of conceptual revision [2] and reformulation especially the classic antithesis of form and matter. Dialectic materialism derives its philosophic soundness from being the first serious attempt to revise the conceptual basis of Western history. (A second one the so-called 'Logik der Geisteswissenschaften [3] has after a few decades referred on owing to its lack of consequence and inherent weakness.) It remains to be seen whether dialectic materialism may turn out to be the only legitimate heir of Hegel as it is claimed by Marxism. But one thing is certain those who continue to ignore Hegel's logic and Marx's conclusions from it have no competence to share in the decision about the epistemologic and ontologic validity of the new trans-classic materialism.

It should be admitted that an unbiased view of dialectic materialism and its proper assessment is difficult. The fault lies with Hegel as well as with Marx and Lenin (Engels may here be ignored. He lacked the profundity of Hegel and Marx and the intellectual incisiveness of Lenin. One does injustice to the theory by judging it from the writings of Engels.) An adequate interpretation of Hegel's logic is still an unaccomplished feat and in Marx as well as in Lenin the practical interest in application stilled the ambition to develop a full-fledged theory of dialectic materialism. Even today the theory is hardly more than an outline, a scientific program which still waits for its executor. The development of an exact logic of dialectic materialism was not a labor to the taste of a man whose probably most quoted statement is the eleventh and final thesis against Feuerbach: "Die Philosophen haben die Welt nur verschieden interpretiert; es kommt darauf an, sie zu verändern."[4] The foundation of dialectic materialism is supposed to be the inverted system of Hegel's logic. But Hegel's text has never been rewritten in a form where Idea changes place with Matter. Marx demonstrated his extraordinary insight in the problem at hand by recognizing that such a rewriting job would be much more than a mere change from idealistic to materialistic terminology and that it would yield a considerable amount of new propositions about the relations between form and matter.

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2 Cf. Hegel IV, pp. 36-58. Hegel will be quoted from the Jubilee edition of Glockner, unless special reference is made to some other source. For the *Critique of Pure Reason* the original pagination is used, as it has become customary, distinguishing the first and second edition as A and B.

3 See Erich Rothacker, Logik und Systematik der Geisteswissenschaften (1927).

4 "the philosophers have interpreted the world in various ways; the point, however, is to change it. "The translation was gratefully copied from F. J. Krieger, Soviet Philosophy, Science and Cybernetics. RAMD corporation, Memorandum RM-3619-PR, May 1963.

From the hindsight of more than a century later it may said that that Marx would not have succeeded anyhow, even if he had tried. His program demands a formalization of Hegel's logic.

But whether a formalistic approach to dialectics is feasible remains a highly controversial issue even now. It is interesting to note that with respect to a formalized theory of dialectic logic the mental climate of the Soviet Union is almost identical with that of the West.[5] Both sides regard the prospect of a mathematization and formalization of Hegel's logic – as the standard work of dialectics – with misgivings and a deep distrust. It is instinctively felt in both camps that the successful accomplishment of such a task would have enormous and partly unforeseeable consequences. In the West it would tear down the defenses of the humanities which hitherto have protected them against the demand to be as logically accurate in the formation of their conceptual structure as the sciences have been forced to be a long time ago. All intellectual life would undergo a fantastic change which would have its repercussions in the moral, political and economic order of Western society. Present concepts of what is "private" and what is "public" would radically change.

In the Marxist orientated countries a mathematical treatment and effective formalization of dialectics would have equally grave implications. For the time being the instrument of dialectic logic is still in the hands of the politicians, i.e., the Party. Sometimes it is cleverly, sometimes it is stupidly but in any case there are no efficient test methods or criteria for the validity of a dialectic argument. It remains the tool of ideological beliefs which are pronounced with religious favor. But should it come to pass that a strictly formalized theory of dialectics – based on laws of mathematical logic – would be developed the control of this even now rather powerful instrument would pass from the Party to the scientists.

A trend pointing in this direction is already noticeable in the Soviet Union. The Communist Government are according go "classic" concepts of Marxism the obedient executor of the Party. And the Party also reigns supreme over the scientists. It has, however, slowly come to pass that the Government begins to assume what might be called the role of Buridan's ass which was equally attracted by two bundles of hay. The two bundles of hay are in this case The Party on one side and natural sciences [on the other side]. The suzerainty of the Party still exists. It may be safely predicted that it will remain so in the foreseeable future – for reasons which will be discussed later. But its reputation for absolute infallibility is on the decline. The Soviet scientists have been able to point out that it erred in several of its *ex cathedra* pronunciamentos. A striking case or the early period of Soviets rule was the condemnation of Einstein's theory o relativity on account of his "idealistic" concepts of space and time. This and similar mistakes by the ideologists are now readily admitted. In the course of such developments the Government has been forced to listen not only to the declarations and decisions of the Party but also to the statements and stipulations of the scientists. It is a moot question which groups exerts as of this moment a greater influence on the executive of the USSR the Party and its ideology of dialectic and historic materialism

5 Ernst Troeltsch, one of the most legitimate successors of the orthodox Hegel and the "Historische Schule" called the dialectic "völlig antimathematisch". Cf. Gesammelte Schriften, vol. III (Der Historismus und seine Probleme. I. Buch: Das logische Problem der Geschichtsphilosophie.) p. 545.

or Science backed by the power of mathematics and objective facts. (It should be added that in this rivalry individual scientists have proved to be as fallible as the ideologists of the regime. A striking example – of even greater historical importance than the question of the compatibility of relativism with Communism was the case of A. M. Joffe (Deborin) which will later be reported [6] with some details. Here the Party showed a much deeper intellectual insight into the issue at hand than not only a group of Soviet scientists but a parallel group of positivistic scientists and philosophers in the West.)

At any rate the present intermediate position of the Soviet Government between Party and Science is basically due to the fact that neither Marx nor Lenin endeavored to provide Communism with a fully developed theory and logical system of dialectic materialism with a clear-cut distinction between Thought and Reality. It has been noted before that Marxism-Leninism remained essentially a program to be fulfilled by the following generations. Marx as well as Lenin were so obsessed with the urge that something should be done immediately that they were not aware of or interested in the disproportion and in congruity between the narrow basis provided by their theoretical statements and the giant dimensions of the practical execution of their historical program.

We have already pointed out that Marx knew that the only philosophic foundation for a conscious transition from the present "capitalistic" epoch of History to the next - and in his opinion final one – could only be the dialectic logic of Hegel. Provided of course that its Christian-idealistic background was abandoned and replaced by the epistemological maxims of materialism.

Whatever else might be said about Marx he has earned himself an unassailable place in the history of philosophy by showing that Hegel's system founded on an idealistic basis is self-contradictory and without a future. But that it may claim to provide the only feasible logical tool for the deliverance of Science from its narrow classic platform and its ontological prejudices. Ernst Troeltsch – being a conservative thinker and thus an unimpeachable witness for Marx – has pointed out that only Marxism deserves the credit for having significantly and usefully developed the Hegelian theory of Dialectics beyond Hegel's own vision of it. [7]

During the last decade of the "Vormärz" (1838-1848), the rest of the century and about the first two decades of the new one prospects for a revival of the Hegelian method of thinking did not look to rosy. A "scientific" myth was fabricated telling the uninformed that "speculative" and transcendental dialectics had "collapsed" and were definitely refuted by the recent advances of natural sciences. In rebuttal of this legend Ernst Troeltsch pointed out in his chapter "Die marxistische Dialektik" [8] that Hegel's logic was neglected, "stifled" because the mental atmosphere changed and the

6 See page.... [note_vgo: this refers to a part of the manuscript which was not finished by Günther].

7 "In ihrem eigentlichen logischen Sinne aufrechterhalten und über Hegels Erkenntnisse hinaus bedeutsam und fruchtbar fortgebildet worden ist die Dialektik nur im Marxismus" – Cf. ref.[5] p. 315.

8 Cf. ref.[5] p. 314-371.

intellectual interest turned to other topic but it has never "intrinsically refuted"[9]. Only Marxism maintained its interest in it, trying to adapt it to the new situation and by doing so changing and sometimes distorting it. The modern critic scrutinizing Marxism-Leninism and its emphasis on dialectics should always keep in mind that two entirely different evaluations of the theory of dialectic logic are possible. First, one might look at it as a doctrine which was used, adapted and (in the eyes of the Western scholars) warped for the sake of political and revolutionary aims. Second, one could also analyze it as a purely theoretical and abstract systematic view of logic with complete disregard for possible applications in the sense of Marx and his followers. After all the idea of dialectics is at least as old as the Platonic dialogue. Aristotle recommends its use in his Topic. The dialectic "meta-theorem" of Stoic logic is considered to be a culmination point of this doctrine.[10] Dialectics plays its part in the structural build-up of Plotin's Enneads in the Syrian Neoplatonism of Iamblichus and others. Neo-platonism influenced medieval logic to a considerable degree. And it should not be forgotten that such a sober logician as Kant devotes in his *Critique of Pure Reason* only 228 pages to Aristotelian basis of logic and its transcendental aspects (Transzendentale Dialektik) [11] The dialectic character of Hegel's logic with its complete absorption of all non-dialectic formalisms is an inevitable conclusion from statements made by Kant in his transcendental dialectics. [12]

If the second view-point is taken it should be possible to evaluate dialectic logic and – as one of its possible implications dialectic materialism according to their own merits and not as inextricably enmeshed, and partially identical with, the political theory of Marxism-Leninism.

Such an approach has become necessary since the advent of cybernetics in the Soviet Union. Although the recognition of cybernetics in Russia has been rather recent Marxist theorists have nevertheless found it necessary to confront the new science with their ideology. It was felt from the very beginning among soviet philosophers that cybernetic theory was considerable more than one new technical discipline among others developing a partial scientific aspect beside other coordinated view-points. Its universal interdisciplinary character which stemmed from new, trans-classic epistemological and ontological assumption was quickly recognized in the Soviet Union. This raised at once the question whether cybernetics (and its implied philosophic assumptions) were compatible with Marxism-Leninism and its conceptual basis of dialectic materialism.

At first the answer was wholly negative. An anonymous author wrote 1953 – five years after publication of Norbert Wiener's "Cybernetics: Or Control and Communication in the Animal and in the Machine" (New York 1948) – in Voprosy Filosofii that "Cybernetics serves the reactionaries of bourgeois society and idealistic

9 "Die veränderte Atmosphäre hat (das Hegelsche System) erstickt, nicht die Logik von innen her überwunden." - Cf. ref.[5] p. 314.

10 Cf. I. M. Bochenski: "Formale Logik" (Freiburg/München 1956) p. 147 f.

11 Count of the pages Meiner's edition, Philosophische Bibliothek, vol. 37a (1956)

12 Cf. Richard Kroner: "Von Kant bis Hegel", vol. I and II. (Tübingen 1921)

philosophy."[13] But the tenor of the comments on cybernetics changed rapidly – and not only in the Soviet Union. This change is heralded by the six "Dialogues on Cybernetics" which were published in Warsaw in 1954 by Bognslavski, Grenievsky and Szapiro [14]. The dialogues admit that the theory of programming of computers, of transmission of information and prosthetic technique are compatible with Marxist concepts. In the very same year a lecture was delivered by Arnost Kolman at the Academy of Social Sciences in Moscow (November 1954) were this scholar, who became later the director of the *Philosophic Institute of the Czechoslovakian Academy of Sciences*, made the following statement:

> "Cybernetics are indeed used by the reactionaries to "freshen" bourgeois sociology and idealistic philosophy and give them a scientific coating... They looked at cybernetics as a novel field of sciences only under this narrow view-point (of the regeneration of bourgeois thinking) and neglected all positive aspects of it. Around cybernetics a large and far reaching movement has developed in the West. It is, of course, very easy and simple to defame cybernetics as mystifying and unscientific. In my opinion, however, it would be a mistake to assume that our enemies are busy with nonsensical things, that they waste enormous means, create institutes, arrange national conferences and international congresses, publish magazines – and all that only for the purpose to discredit the teachings of Pavlov and to drag in idealism and metaphysics into psychology and sociology. There are more effective and low expensive means than the occupation with cybernetics if one intends to pursue idealistic and military propaganda." [15]

Kolman made his position very clear and demanded that not only mathematicians and technicians should pay attention to cybernetic theories but that Marxist philosophers should also consider it and reverse their extremely negative attitude. [16]

Kolman deserves the credit for being the first to have defended cybernetics under circumstances which made him widely heard against the ideologically orientated attacks by professional Marxists.[17] From then on things started to move rapidly. The XXth Party Congress (Febr. 1956) might be considered the starting line for an

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13 For more quotations in the same vein, see Roger Levien and M. E. Maron: "Cybernetics and Its Development in the Soviet Union", Memorandum RM-4156-PR, July 1964, RAMD Corporation. The 1963 edition of M. M. Rozental' and P-F. Yudin: "Kratky filosofsky slovar" (Short Philosophic Dictionary) has changed its tone. The value of cybernetics is not conceded for the automatization of production, for biological mechanisms of hormonal, nervous or hereditary nature and for some technical aspects of medicine. "Promising also is the application of cybernetic methods to the structure of economics as well as other fields of organized human activity." p. 197.

14 Stanislav Boguslavski, Henryk Grenievski, Jerzy Szapiro, "Dialogi o cybernetyce", Myśl filozoficzna IV (14) pp 158-212.

15 Quoted from Helmut Dahm, "Zur Konzeption der Kybernetik im dialektischen Materialismus" (Unpublished manuscript, p. 25)

16 According to Dahm (see note 15) who based his statements on a revised short-hand copy of Kolman's lecture which was printed in "Voprosy filosofii" (1955)

17 There might have been similar defenses by other which were not published. One of the first computers of the Soviet Union, the BESM, was already completed in 1953 and computer study and experimental work had been carried on even before that time (see RAND-Memorandum RM-4156-PR, p. 17). this would have been impossible in an atmosphere unreservedly inimical to cybernetics. Thus it is probable that Kolman only voiced opinion in public which had been privately uttered by many of his colleagues.

accelerated automatization of Soviet industry and for a development which finally led to the practical capitulation of the ideologists to cybernetics. Such surrender was unavoidable since the Government permitted the translation into Russian language of the original sources of cybernetic research.

C. Shannon's information theory was accessible to Soviet scholars as early as 1956. [18] Very shortly afterwards (1958) Norbert Wiener's "Cybernetics" was translated. His – to Marxist readers much more controversial – next book: "The Human Use of Human Beings" was also made available to Soviet scholars. Only a year later W. Ross Ashby's: "An Introduction to Cybernetics" appeared in a Russian edition. The previous work: "Design for a Brain" followed exactly ten years after its first publication (1952) in New York. [19] At this time of the translation of "Design for a Brain" the reception and absorption of Western cybernetics was already in full swing. In 1960 a series of translations for cybernetic works from the West was introduced under the general title, "Cybernetics Collections" [20]. So far (July 1964) six volumes have been printed.

The time from approximately 1960 to 1962 are the decisive years of some sort of Ideological Breakthrough and for the beginning of an intellectual revolution in Russia which will unavoidably enforce a re-evaluation of the Marxist-Leninist foundation of the Soviet system. It is the time when one begins to speak of a "dialectic conception of Cybernetics". In 1960 an official organ of Leningrad University: *Vestnik Leningradskogo Universiteta* published an essay by L. A. Petruchenko were the following interesting statement was made: "The continuous chance change of the difference (opposition) between the given and the effective state of a system is for cybernetics only the observable expression of a much deeper and more radical opposition between information and entropy since information presents a measure of organization entropy on the other hand a measure of disorganization of any system. The contradiction between information and entropy, between order and disorder may be regarded as the basic contradiction of the cybernetic system ... (seen from here) the principle of feed-back ... possibly represents a sort of dialectic movement." Petrushenko does not fail to refer to Lenin in this context to show that feed-back is an element which fits well into the dialectic principle of the official doctrine. [21]

Much more aggressive are the words by which Georg Klaus claims cybernetics for dialectic materialism in the introductory passages of his book "Kybernetik in philosophischer Sicht" (The first edition for this ideologically interesting work was published in 1961). Klaus starts by referring to Lenin's thesis of 1908 that modern physics is on its way to develop dialectic materialism: "Modern physics is about to

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18 It was published among other papers in "Avtomaty" (Moscow 1956).

19 U. Ross Ešbi: "Konstrukcija Mozga" (Moscow 1962).

20 Kiberneticheskij sbornik.

21 L.A. Petrushenko: "Filosofskoe zuačenie ponjatija 'obratnaja svjaz' v kibernetike", in Vestnik Leningradskogo Universiteta. Serija ėkonomiki, filosofii i prava; Leningrad (1960). Translat. German in: Ostprobleme (Godesberg/Bonn 1962) 14, I; pp. 19-27. The German text contains the words 'Bestimmtheit' und 'Unbestimmtheit' which our translation renders: Positiveness and non-positiveness, since the German expressions are specific terms of dialectic (transcendental) logic to which Petrushenko obviously refers.

give birth to dialectic materialism." [22] After a lengthy quotation of Lenin he then continues: "What Lenin says about physics is, in our opinion, even more valid for cybernetics. This science expresses everywhere unconsciously and spontaneously dialectic-materialistic trends of thought. But that means that cybernetics represents in its entirety, in its scientific core (and this core is so massive and so unshakeable that the other, "the garbage", the reactionary philosophic misuse, the epistemological mistakes of important Western cyberneticists etc., can be regarded as irrelevant) a considerably matured subject-matter for philosophic abstraction in the sense of dialectic materialism and it should be considered as one of the most impressive confirmation of dialectic materialism which up to now have come into existence." [23]

Klaus, a true-blooded Communist, is very enthusiastic about the vistas cybernetics has opened up. He predicts for it a gigantic development (riesenhaftes Wachstum) but he adds – carefully and significantly: "One should not limit this new science by some dogmatic boundaries otherwise damage will be done in the philosophic, scientific and finally even the technical and economic field." [24] Klaus concludes his introductory remarks by expressing his indebtedness to his colleagues Poletajew [25], Moissejew [26] and Rowenski [27] and adds: "I have also taken some suggestions form the works of Ashby and Wiener. I could do this, because both, whether they will admit it or not and despite serious philosophic mistakes which appear in their works, produce... clearly recognizable dialectic and materialistic trains of ideas." [28]

There is no doubt cybernetics has since about 1960 arrived in Marxist countries in full splendor. It has arrived not only as a new special discipline with important technical consequences but as a basic theory of deep philosophic significance which is about to enforce the re-examination of certain positions of Marxist ideology. Soviet

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22 "Materialismus und Empiriokritizismus". Werke XIV, p. 316 "Die moderne Physik liegt in Geburtswehen. Sie ist dabei den dialektischen Materialismus zu gebären." (Modern physics is in throes of birth-pains. It is about to give birth to dialectic materialism.)

23 Quoted from the third (revised) edition. (1963) p. 22. The translated passage however, was already part of the first edition of 1961.

24 Loc. cit. p. 23.

25 I. A. Poletajew, known as author of: "Kybernetik". Eine kurze Einführung in die neue Wissenschaft. (Berlin 1962).

26 W. D. Moissejew. Known as author of: "Fragen der Kybernetik in Biologie und Medizin". (Berlin 1963)

27 S. Rowenski. Co-author of: "Maschine und Gedanke", "Philosophische Probleme der Kybernetik" together with A. Ujemow, J. Ujemowa. (Leipzig, Jena, Berlin 1962).

28 Loc. cit. p. 24. Italics from the present authors (For Ashby as "dialectic materialism"). See also p. 51, pp. 206-218, 247f, 363f, 394f, 523. For Wiener we learn on p. 177 "... that his materialism is essentially identical with mechanical materialism." He uses a concept of materialism in principle false and unscientific. The same we are told p. 331, p. 351 and p. 355. It seems Klaus is not quite consistent. It is true that Ashby is - apart from p. 24 - six times described as willy-nilly harboring tendencies of dialectic materialism. In the introduction, the same is claimed for Wiener (p. 24). But the text afterwards accuses him only as a cyberneticist who knows nothing but the false mechanistic principle of materialism. There would of course have been some opportunity to claim Wiener for dialectic materialism if Klaus had been digging a little deeper and directed his attention to Wieners distinction between Newtonian and Bergsonian time which is the topic of the first chapter of "Cybernetics...". The relation of reversible to irreversible time in physical systems has indeed ´dialectic´ character. (Cf. Hegel IX (System der Philosophie III) p. 3221f.

scholars concerned with the new field of knowledge begin to speak to the ideologist of dialectic materialism in a language they would not have dared to use several years ago.

An example in kind is an article by P.L. Kapitza, entitled "Theory, Experiment, Practice" (*Teoriya, eksperiment, practica*) which appeared in *Ekonomicheskaya Gazeta*, Moscow 34, 13 (March 26, 1962). There the well-known Academician wrote:

> "The separation of the theory from experiment and practice is especially damaging for the theory. I want to prove this idea by means of the work of the philosophers who are dealing with the philosophic problems of natural science. There is a discipline which is conventionally called: Cybernetics. What this name means and which enormous part cybernetics play in the modern social life is known to many people. Nevertheless one can read in the fourth edition of the "Philosophic Dictionary" about it: "Cybernetics (from the Greek word for steersman) is a reactionary pseudo-science which originated in the United States after the second world war and which also received wide dissemination in other capitalistic countries; a form of modern mechanizism."
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> "It is a fact that this statement about cybernetics is contained in book which has been written 8 years ago; and in the meantime the mistake has been corrected. On the other hand it is the task of the philosophers to predict the development of natural science and not just to take cognizance of a way which has already been covered.
>
> "If our scientists had listened to the philosophers and taken the above definition (of cybernetics) as valid for the future development of this disciple the conquest of Space - which we are justly proud of and for which we are honored in all the world - would not have happened. Space-ships cannot be controlled without cybernetic machines". [29]

It should not be forgotten that for all practical intents and purposes "philosopher" means in Russia ideologist and interpreter of the Party-line. Any other kind of philosophic reflection inadmissible and will not be printed. [30] Kapitza's attack against Soviet philosophy is therefore a more ore less indirect assault of the Party. It is symptomatic for the changing political and mental climate that it is now possible to accuse the Party – even if indirectly – of failing to provide the intellectual leadership which is its self-assumed obligation. It goes without saying that only persons of the scientific stature of Kapitz and Kolman and others in similar positions and of equal value to the system can as yet afford to do so. But attacks of this kind must have been numerous and probably rather aggressive. Because a need was felt to smooth the ruffled feelings of the ideologists and to reach some sort of reconciliation. An indication of such efforts is an article by Aksel I. Berg, a member of the Academy of Sciences, an admiral in the Soviet Navy and a former Deputy Minister of Defence. Berg's essay appeared in Voprosi filosofii (philosophical problems) and it dealt with Norbert Wiener presented in his book "Cybernetics, or Control and Communication in the Animal and the Machine..." were offered with hazy had sometimes even false ideologic-philosophical view-points. An unhealthy activity originated around the ideas of Wiener. The Western press took great pains to render superficial the very profound and valuable ideas of the author of "Cybernetics..." and to present them in distorted

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29 Quoted and translated from the German text by Helmut Dahm. Loc. cit. p. 19 f.

30 Between 1922 and 1930 a few exceptions were still made and it was possible, but dangerous, to have ideas published which were tamely heretic. This stopped completely after 1930. The indissoluble unity of philosophy and (Marxist) politics was reaffirmed early in 1931. Cf. I. M. Bocheński's very informative book: "Der sowjetrussische dialektische Materialismus" (Dalp-Taschenbücher vol. 325. Second ed. 1956) p. 36.

form. All this produced caution and distrust of this discipline with some part of the Soviet intelligentsia. Unfortunately it is a fact that this long procrastination in producing a sensible relation to cybernetics has undoubtedly been detrimental to our science and technique. On should draw the corresponding conclusion from it, since one may count on it that also in the future many deserving and useful ideas may arrive in similar ideological disguises." [31]

The attempt to mollify the ideologists and make excuses for them is obvious. On the other hand Berg's remarks serve notice on the Party and on the ideologically orientated part of the intelligentsia that cybernetics has come to stay and that it poses for all Marxists the problem to reconcile the official doctrine with it. And if anything has to give in the process it will not be cybernetics because the argument of the latter are formulas of symbolic logic and mathematics not to forget the "hard-ware" that has and can be built.

In this context we would like once more to refer back to Georg Klaus' statement that cybernetics represents in its core "the most impressive confirmation of dialectic materialism." Since the first edition of his book was published in 1961 (and Klaus is a professor at the East German Humboldt University of Berlin) it must have been possible to state and write such opinions at least in 1960. In order to evaluate this fact, one should be aware that of all countries within the Soviet orbit Stalinism exerts still its strongest influence in East Germany, and that there even a scholar of stature has to toe the Party-line much more carefully than his colleague at the Academy of Sciences in Moscow would find it necessary. Klaus' book has so far had three editions in East Germany. It has been translated into Russian language and the Moscow edition was scheduled for the last part of 1963.[32]

There can be no doubt but that a re-examination of the philosophic doctrines of Marxism-Leninism is in the offing. Which results will emerge from it this author would not care to predict. However, one thing should be made clear no matter what influence cybernetics is gaining in the Communist world and no matter how it will modify its intellectual as well as its political and social character it will not lead to a philosophic overthrow and extirpation of Marxism-Leninism! This cannot be emphasized too strongly. There exists – especially in the USA – wide-spread opinion that "Cybernetics is a science with ideological implications that contradict and challenge the basis tenets of Soviet Marxism-Leninism." This statement which is contained in Memorandum RM-4156-PR (July 1964) of the RAMD-Corporation,[33] should be taken with more than a grain of salt. It is based on a premise which is – for the time being at least – unallowable. This premise is that we

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31 Cf. "Ost-Probleme", (Bonn 1960) XII, 18. p. 546-556. Voprosi filosofii (1960) 14,5. p. 51-62. Helmut Dahm adds (Loc. cit. 22) that Berg is not quite correct in his description of the situation. Some Marxist journals tried already in 1955 to introduce some cybernetic aspects in genetics, neurophysiology, psychology, sociology, and even ontology into the philosophy of dialectic materialism. The quotation in the text stems from an article by Berg: "Some problems in cybernetics". This essay has been translated and published in English language by the "US Joint Publications Search Service" (JPRS) 3953-CSO: 4284-D. (OTS: 60-31,781) There the quoted passage is found p. 4 f. This author's translation is based on "Ostprobleme".

32 When the text was written no information was available to the author whether the book is now available for Russian readers.

33 Loc. cit p. 16.

know what the philosophic ontological significance of cybernetics is. Marxism-Leninism is based on a profound "metaphysical" theory: namely Marx' interpretation of Hegel. Soviet Marxism-Leninism is an application of it. With cybernetics the case is very different. At present cybernetics is hardly more than a rapidly growing field of empirical techniques. Its underlying logical, epistemological – let alone ontological – principles are not even dimly understood. Cyberneticists are at best vaguely aware that their way to look at the Universe seems to contradict an old and established world-conception (Weltanschauung) which grew out of the principles of classic ontology. But this is about all that may be said as of this moment about its "ideological implications". Significantly, the very same Memorandum from which the statement above was taken presents from another author the following admission: "Cybernetics denotes many things to many people and, even among experts, there is no complete and precise agreement as to its content." [34] This is undoubtedly correct.

But this leaves us in an awkward position. While Marxism-Leninism is founded on a philosophic theory cybernetics most decidedly is not. But that makes it patently impossible to compare both as to their ideological (or better: ontological) content. Thus we are not in a position to say that cybernetics contradicts the basic tenets of the world-conception on which life in the Soviet system is based.

It is a different proposition if one confines oneself to the statement that cybernetics constitutes a challenge. But this challenge might address itself with equal force to the Western civilization and the Soviet system. Since it is an historic fact that Marx developed his theory in exact contraposition to the "traditional" or "conservative" interpretation of Hegel which constitutes and encompasses all that is left of classic ideology and metaphysics in the Western World, three logical possibilities exist for the part cybernetics is playing in the present ideological set-up of human society:

a) cybernetics agrees with Western tradition and challenges Marxism;
b) cybernetics challenges Western tradition and does not challenge Marxism;
c) cybernetics challenges both Western tradition as well as Marxism.

A fourth possibility: that cybernetics agrees with Western tradition as well as with Marxism must be ruled out *ab ovo* since Marx' philosophic basis is a contradictorial inversion of Hegel's logic.

If we assume case a) to be true then the challenge of Marxism might develop into a down-right contradiction of the ontological tenets of Marxism-Leninism. But the Western scientist and scholar can hardly assert a). One does not need cybernetics to demonstrate that our traditional concept of ontology is rapidly on the wane. The gradual dissolution of our classic ontological concepts has been recognized long ago in theoretical and experimental physics

From the many voices which have testified to this fact (e.g. W. Heisenberg, H. Weyl, E. Schrödinger, C. F. v. Weizäcker) we will suffice quote W. Heisenberg: "...the change in the concept of reality manifesting itself in quantum theory is not simply a continuation of the past; it seems to be a real break in the structure of modern science" [35] If this is the case for quantum theory it must also be true for cybernetics since the

34 Loc. cit. p. 2.

35 "Physics and Philosophy", (New York 1958) p. 29.

latter depends in certain respect on the characteristics of the former. But this rules out the assumption of a).

With regard to the next case b) it may be said that the refutation of a) already implies the acceptance of the first part of thesis b). This position seems to be taken by Georg Klaus – although even this scientist would concede the possibility of minor revisions under given circumstances. The philosophic relevance of cybernetics could be considered as a major challenge to dialectic materialism and as a motive to a thorough re-examination of the legitimacy of Marx' contention of the inversion of Hegel's Science of Logic. An investigation of this sort might lead to a reconfirmation of dialectic materialism but with major and fundamental changes in the basic theory. These changes could be so sweeping as to involve far reaching of the present communist ideology – which is not indissolubly bound up with dialectic materialism and would be easily changeable in a favorable political climate.

The 3rd possibility, of course, is that a re-examination of Soviet philosophic thinking induced or even enforced by cybernetics could bring about the down-fall of the theory of dialectics as embodied in dialectic materialism. Then the doctrine of historical materialism would also go and with it is concomitant ideological trappings.[36]

We anticipate results of an analysis of the problem at hand on the later pages of this text when we state that this last and most radical possible consequence of the advent of cybernetics in the world of dialectic materialism can practically ruled out. If Marxism-Leninism undertakes a sincere self-analysis – which seemed to be due even before the advent of cybernetics – it has, of course to consider the theoretical possibility of a complete departure from the principle of dialectics and dialectic materialism.

But is Marxism really above a challenge from cybernetics? As to this question the present attitude of philosophers and scientists in the orbit of Communism seems to be ambiguous. The opinion of S. Klaus seems to be that cybernetics represents a triumphal confirmation of dialectic materialism and constitutes no challenge at all to the ways of Marxist-Leninist thinking. Although Klaus, if hard pressed, would probably admit that minor modifications of the dialectic theory (just cybernetics plays, in the words of Klaus, only the part of "a considerably matured subject-matter for philosophic abstraction in the sense of dialectic materialism"). If this, however, is the case then cybernetics has no more philosophic significance than other old-fashioned disciplines which also are supposed to serve as confirmations of a philosophic-political theory. The theory permits no alternation of its principles and if an empirical science does not conform to its expected role of a prop of dialectic materialism the

36 A symptom which indicates such tendencies is the publication of J. H. Findlay's book on Hegel (London 1958). In this very solid "re-examination" the author succeeds in showing that Hegel "is misconceived, first of all, as being a transcendent metaphysician" (p. 15). He then disposes efficiently of the "subjectivist charge" against Hegel. He even rises to some sort of defense of dialectics (pp. 73-79). And one can only agree reading: "We may hold, in fact, that Hegel's notion and (dialectic) use of contradiction, confusing as it in many ways is, none the less embodies, one of the most important of philosophical discoveries, whose full depth has not even yet been properly assessed" (p. 76). Findlay's work shows clearly that the author is – probably without being aware of it – on his way not to straight dialectic materialism in the radical sense of Soviet philosophy but to a position in which the epistemological conception of dialectic materialism will play an important role. It is the way along which certain recent logical analyses of quantum mechanics and cybernetics are drifting.

resulting disharmony between decreed doctrine and practical experience is not to be solved by an alteration of the basic theoretical frame but by a re-interpretation of the empirical facts. In this sense the various scientific disciplines are just "subject-matter" for the sovereign use of the ideological theory. But if Klaus and his colleagues in the East assign to cybernetics such a supporting character where the new sciences is only permitted to serve an unmovable doctrine obediently without being capable to prompt a revision of the basic tenets of dialectic materialism then no ground exists to speak of the philosophic significance of cybernetics. But Klaus himself refers to the "Weltanschaulichen Konsequenzen" of the new science apart from the changes it way induce in social life and in other particular scientific disciplines. [37] It is obvious that Klaus' voice is only an echo of opinions and epistemological attitudes which have already taken root in Moscow. A professor at the Humboldt University in East Germany told not afford to propagate ideas without the previous stamp of approval from what has so far been the ideological center of Marxism-Leninism.

At any rate, for the time being it remains obscure what it meant if a Marxist admits to a certain philosophic significance of cybernetics. If its defenders do not think that the basic concepts of dialectic and historical materialism are involved and affected in this case they should come out and say so. It would immensely strengthen their present position with the Party ideologists. Instead of it Klaus, for instance, points out that the new science should not be hampered by "dogmatic limits" [38] But this means serving notice to Marxist philosophers that a revision of some basic tenets of Marxism-Leninism cannot be ruled out. If Klaus' attitude is ambiguous it mirrors exactly the situation in the Soviet Union. There too cybernetics is, as far as its philosophic significance is concerned, enveloped in a hazy twilight. In his essay "Some Problems of Cybernetics" (see note 31) A. I. Berg declares that:

> "Cybernetics has its philosophic problems as well as mathematics, physics and biology have, but it is deeply erroneous to regard cybernetics as a philosophic theory which would be capable of replacing dialectic materialism. Dialectic Materialism is a science which deals with the more general laws of the development of nature, human society, and thought. The main feature of the philosophy is that it is a world view. A world view of the world around them and answers the questions: What is the world? Does it remain unchanged, or is it constantly developing and changing? What place in it do mankind and human society occupy? The problem of the relationship of human consciousness to existence, spirit to matter of that which is fundamental, primordial – surrounding nature: It is matter, or just thought, spirit, reason or ideas? ... This is the main problem of philosophy as a world view. These are all well-known truths, however, it is already apparent from this general characteristic of philosophy that cybernetics differs in so far as it is incommensurable in the object of its study, the problem set before it, and in the breadth of its generalizations. Although cybernetics deals with complex developing processes, it investigates them only from the point of view of the mechanism of control. The energy relationship, and the economic, aesthetic and social aspect of the phenomena which occur are of no interest to cybernetics ... Although cybernetics is based on wide generalizations which are correct for all control systems, it has a scientific basis that is incommensurably more narrow than philosophy.

37 Loc. cit. p. 20.

38 Loc. cit p. 23.

Cybernetics has no type of principles which purport to replace or substitute materialistic philosophy." [39]

This seems to be very clear and unequivocal. The Soviet position is quite clear: no positive, scientific discipline can ever refute dialectic materialism. But since nobody can ever predict what new sciences with as yet unforeseeable epistemological premises may turn up in the future the words of Berg express only a pious belief. Particular have, of course, their philosophic problems this is conceded but they are not of first ontological order. Thus they cannot affect the first order ontology of dialectic materialism.

The Western critic, will of course, object to this attitude. He will argue that the unity of philosophy and especially of logic is destroyed if we are supposed to assume that individual sciences have their private departmental philosophies which are in principle incapable to be relevant for the truth-character of the basic, interdisciplinary philosophic system which happens in this case to be dialectic materialism. The issue of the unity of logic which involves that of philosophy in general is in fact a pressing problem of Soviet philosophy. There have been heated controversies about the relation of formal to dialectic logic after the original ban about logical formalism was lifted. No satisfactory solution so far has been found and it is safe to predict that the discussion between formalists and dialecticians will continue into the future. The formalists represent, of course, the position of the empirical sciences against the dialectic ontology of Marxism-Leninism. The philosophic problems of individual scientific disciplines are supposed of a mere formal-mathematical nature and for this very reason for ever incapable of rebutting the non-formal essence of Dialectic Materialism. Starting from this (controversial) distinction of formal and dialectic logic Berg inevitably arrives at the conclusion: "that Cybernetics has no type of principles which purport to replace or substitute materialistic (dialectic) philosophy.

At this point a comment is in order. It would be very erroneous to believe that serious Marxist scientists make such statements with regard to dialectic materialism because they are under an ideological pressure by the Party or the Government. Such pressure exists undoubtedly and may have the described effect in many cases. But in perhaps the majority of scientist and scholars who are confronted with the problem of relation between science and philosophy the belief that no scientific statement can ever refute and disprove the basic tenets of dialectic materialism is undoubtedly sincere. In fact it is more of a belief it is a knowledge based on two undisputed facts. First, the theory of dialectics is of a higher logical order than any formal-mathematical logic a particular scientific discipline may apply. Second, in the development of logic from the pre-Kantian to the post-Hegelian stage the concept of the "Transzendental-dialektische Logik" has been bypassed together with its ontological motives. But neither these motives nor their logical implications have ever been voided by the West. [40] Soon after the death of Hegel Western philosophic reflection got more and under the influence of the causality thinking of natural science, style 19th century. This 19th century influence even persisted after natural science started to abandon its former

39 Loc. cit. p. 5 f.

40 Cf. note 9. Symptomatic for the attitude of the West is K. Vorländer's: "Kant und Marx" (Tübingen, 1910). Vorländer replaces the Hegelian-Marxism dialectics by "historic" causality. This became quite a fashion.

position around the turn of the century. This scientific climate was most unfavorable to dialectic and the theory of transcendental dialectic logic was abandoned (except in the writings of Marx and his followers). [41] It plays no part in the rapid evolution of modern logic since the middle of the last century. This did not happen because the methods of Kant, Fichte and Hegel proved to be unmanageable in the field of logical calculus. It happened because the ontological problems which led to the writing of the *Critique of Pure Reason*, the "Wissenschaftslehre" and Hegel's "Wissenschaft der Logik" were less and less understood and finally almost completely forgotten because they were not the problems of natural science in the 19th century. Even the social sciences and the humanities were infected by this trend. Although the representatives of the *Geisteswissenschaften* loudly proclaimed the "essential" difference of their disciplines from mathematics and natural science they tenaciously clung to the traditional logic which was just the organum on which all natural science up to and including the 19th century was based.

The widely advertised "Logik der Geisteswissenschaften" remained a newer implemented program and every attempt of a real departure from classic (two-valued) logic was and is still regarded with a deep distrust. The deep irony of the situation is that, while social sciences and humanities are still desperately clasping the life-belt of classic logic, physics and mathematics made every effort to depart from Platonism and Aristotelism in logic. They showed a readiness to give up obsolete concepts which was sadly mining in the *Geisteswissenschaften* [life sciences] and philosophy. As far as logic is concerned the result was inevitable. Already in 1922 Ernst Troeltsch judged contemporary logic as being in the state of "Subjectivistic devastation". [42] Logic became the almost exclusive domain of conventionalism and logical positivism and logical problems such as Kant, Fichte and Hegel had developed were declared to be "Scheinprobleme" (pseudo-problems)." [43]

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41 Th. Litt, loc. cit. p. 287: "... Wir trennen uns von (Hegel), wenn er die These von der Inhaltsbezogenheit der Logik zu der Behauptung fortbildet, es sei dieser Logik gegeben, den fraglichen Inhalt durch dialektisch fortschreitende Entwicklung ihrer selbst zu erzeugen." But this is just the point where Marx and Lenin follow Hegel. Litt is – despite its attempt of a rejuvenation ("kritische Erinnerung") of Hegel at typical representation of Western thinking. As further example of the anti-dialectic attitude of Western philosophers we quote from J.H. Findlay´s Hegel book: "The supreme defect of Hegel's dialectic treatment of notions lies ... in his view that dialectic development follows definite values ... that it can be regimented into a sequence of triads, that it constitutes a new sort of knowledge or science, having some sort of rigor of its own even if not the rigor of other scientific disciplines. If the painful analyses of this book have established anything, it is that there is no definite method called dialectic ...". Loc. cit. p. 357f. This statement of Findlay should be compared with the one, re-dialectics, in note 37. On the one hand there are unmistakable symptoms that the West is being forced into some confrontation with the problem of dialectics and some sort of recognition of it. On the other hand the attitude persists that dialectics have no rigorous scientific core. But this is just the contention of the Marxist-Leninist.

42 Loc. cit. "...die (in der Antike und im Mittelalter bis) in die letzten Tiefen zurückverfolgte Logik (ist) in der modernen Welt verfallen und subjektivistisch verwüstet." p. 104.

43 See, Rudolf Carnap: "Logische Syntax der Sprache" (Wien 1934) p. 196, p. 238 ff. Also from the same author: "Die alte und die neue Logik", Erkenntnis I (Leipzig 1930) p. 12 -26. - Against this radical attitude see H. Scholz: "Der Positivismus ist aufgebläht worden zu einem Erfahrungsmaterialismus, der nicht nur gegen die Übergriffe und Prätentionen des absoluten Geistes protestiert, sondern gegen den Geist überhaupt, und zunächst gegen die Selbsttätigkeit dieses Geistes in der Physik." Mathesis Universalis (Basel/Stuttgart 1961) p. 392.

One has to be aware this de-ontologization of logic and philosophy in general to understand the posture of superiority and infallibility the followers of Marxism-Leninism assume then they speak of dialectic materialism as the unquestionable philosophic basis of modern science as well as of social life and politics. Since the West has – as far as science is concerned – discarded the problems of dialectics, of self-reflection, and everything else that is new in Hegel's logic, as "Scheinprobleme" no Western scholar is in the opinion of his Eastern counterpart in a position to judge the merits of dialectic materialism. Since he is ever aware of the existence of the problem how could he discuss the possible solutions it might imply.

It should be admitted that this criticism is well founded in the history of Western thought since the death of Hegel in 1831. Hegel and his dialectic logic was, despite the weakly and inconsistent attempt of a Hegel-Renaissance, discarded. His theories meant nothing to budding natural science. In the *Geisteswissenschaften* only an emasculated Hegel without the life-blood of his dialectic logic was welcome. It is true that the Anglo-Saxon world succumbed to some degree during the last half of the 19th century and the first quarter of the present one to the allure of Hegel. Hutchinson Stirling published his "Secret of Hegel" in 1865. It was followed by F. M. Bradley's "Principles of Logic" in 1883 and his "Appearance of Reality" in 1893. Also W. Wallace, Th. H. Hodgson and E. Caird fell under the influence of Hegel. Bernhard Bosanqet's important "Logic", or the "Morphology of Knowledge" was first printed in Oxford in 1888. Three years after his "Knowledge and Reality" had been published. McTaggart's "Studies in Hegelian Dialectic" and "Commentary on Hegel's Logic" came out in 1896 and 1910. Significant for the role Hegel played in work of his epigones is also the work of M. Fairbairn (1838-1912) who made a valiant attempt to connect Hegelianism with orthodox theology. In the US Hegel obtained influence first in Missouri (St. Louis) through the efforts of Henry Brokmeyer as well as Torrey Harris and Denton J. Snider who published the "Journal of Speculative Philosophy" from 1867-1893. When Harris later became United States Commissioner of Education (1889-1906) he tried to put Missouri Hegelianism into political practice "by expounding it as a theory of education and by representing the institution of national, public education as the culminative embodiment of freedom." [44]

One has to admit, however, that Hegel never exerted more than a superficial influence on the development of a pure systematic theory in American philosophy, despite Laurens P. Hickok's "Logic of Reason" (1875) and Alfred H. Lloyd "Dynamic Idealism" (1898). Transcendentalism and dialectic idealism which were characteristically separated in the philosophy of the USA were never able to fuse [45] even after they met at Concord Summer School of Philosophy. Neither movement possessed enough affinity to American thinking in order to make it possible for both of them to launch conjointly a basic philosophic tradition which might have been considered a legitimate continuation of the idealistic tradition form Plato and Aristotle to Kant and Hegel.

It is in view of Marx' criticism of dialectic idealism significant that the lasting influence Hegel did exert on the North-American continent was rather political and economical. If we follow H. W. Schneider we may say that "the impact of Hegel on

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44 Herbert W. Schneider: "A History of American Philosophy" (New York 1946) p. 184. See esp. chapter 15, p. 171-193.

45 H.W. Schneider, Loc. cit. p. 184.

democratic theory in America was greater than is generally believed, and it is scarcely an exaggeration to claim that it was primarily the Hegelian influence which prevented national collectivism ... from taking a decidedly undemocratic turn and gave America an appropriate ideology for understanding the growth after 1880 of national socialism and economic democracy." [46] In this sense the influence especially of Hegel's "Grundlinien der Philsophie des Rechts" still persists. But as a foundation of scientific logic and epistemology Hegelianism has completely disappeared from the world of Anglo-Saxonian thinking. The (mostly) German and Italian attempt to translate Hegel into a "Logik der Geisteswissenschaften" misfired, apart from other reasons, because a logical distinction between natural sciences and *Geisteswissenschaften* is completely un-Hegelian.

It remains to be seen whether this disappearance is final or whether this has only been the first period of Hegel's influence on a world-wide scale and a second is still to follow. [47] But for the time being there exists a situation where philosophers and scientists of the Marxist-Leninist world may rightly feel to be in an superior position. It is an uncontestable fact that Science in the Western World has been going along without a basic philosophic ontology and concomitant theory of logic for a considerable period of time. One might say that Leibniz was the philosopher of world-historic rank who provided in his Monadology an ontological platform for Science but as far as the complementary system of logic was concerned he never succeeded in doing more but to make suggestions for its future implementation. He dimly perceived that the logic of the future world be a generalized theory of combinatorics. But he could not succeed in developing the idea of logic he envisioned because the Monodology – although a step in the right direction – afforded too narrow a *locus standi* for his purpose. It should be pointed out, however, that his concept of the

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46 Loc. cit. p. 177f.

47 It seems debatable whether the publication of Findlay's: "Hegel..." (see note 36) is the harbinger of such a second period of Hegelianism in the Anglo-Saxon world and whether the European Hegel-Renaissance might have a counter-part in non-European countries. Findlay certainly succeeds in making Hegel palatable to thinkers to whom the atmosphere of European metaphysics is completely alien when he demonstrates in his careful analyses that Hegel is an anti-metaphysician as well as a consistent empiricist. It is worthwhile to quote some of the statements of his final summing-up: "...despite much opinion to the contrary, Hegel's philosophy is one of the most anti-metaphysical of philosophic systems, one that remains most within the pale of ordinary experience, and which accords no place to entities or properties lying beyond experience, or to fact undiscoverable by ordinary methods of investigation. Hegel often speaks the language of a metaphysical theology, but such language, it is plain, is a mere concession to the pictorial mode of religions expression. As a philosopher, Hegel believes in no God and no Absolute except one that is revealed and known in certain experiences of individual human beings, to whose being it is essential to be so revealed and known... For Hegel there can be no absolute, infinite experience which is not also, from another point of view, limited and personal, nor can the Whole appear otherwise than in the perspective of an individual consciousness, stamped with the ineffaceable mark of the Here and the How... If Hegel shows no tendency to go beyond the finite, individual, human consciousness, but merely to give depth to our idea of it, he shows just as little tendency to go beneath the world of natural things in Space and Time, or to undermine what would ordinarily be called their reality... One may likewise hold that Heel shows no tendency to overthrow or undermine the facts, assumptions or methods of the mathematical or natural sciences. To read the treatment of Knowledge at the end of the L o g i c is to be clear in this point... The kind of philosophy which Hegel has built up is... plainly one of the permanent types of philosophy..." p. 353 ff.

monad as a system with mapping capacity *repræsentatio mundi* and self-reference (*monas monadum*) anticipated future developments. Developments which led to a new concept of logic by Hegel. [48]

But it is a hardly disputable fact that Leibniz, despite the pre-cognitional character of his system, does not provide a broad enough ontological sustentation for modern science. On the other hand, all systems between him and Hegel represent only transitional stages of a conceptual development initiated by Leibniz. [49] And from Hegel up to the present day no ontological theory of even remotely equal rank and logical relevance has been conceived. With Hegel the grand procession of world-historic systems which developed thematically basic conceptions of reality as guiding stars of man's scientific efforts and understanding of the world has so far ended.

Since Leibniz' ontological conception of reality is in his sense not acceptable any more and Hegel is ignored by modern science in the West the total effect is that Western science develops without any ultimate philosophic foundation and without any unifying principle. The effects of this ontological anemia are becoming more and more visible any day. Physics produce ever increasing experimental results without an adequate theory to cope with them. In symbolic logic a cancerous growth of formulas accumulates for which no ontological interpretations can be found. A striking example is the question with which the present standard work on many-valued logic ends: "Precisely what problems (if any) can be solved by means of many-valued logics (M > 2) which cannot be solved by the ordinary two-valued logic?"[50]

Here lies the ultimate difference between the scholar and scientist of the West and his counterpart in the East. The latter is in possession of such a system – the re-interpreted Hegel – and he is capable of confronting the results which all the particular scientific disciplines provide with the ontological background of his philosophic theory. If the Western scholar leaves that relativity and quantum mechanics are after a

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48 It has only very recently been recognized that Hegel as logician is the legitimate successor of Leibniz besides modern symbolic logic. Cf. the excellent monograph by Hans Heinz Holz: "Leibniz" (Urban-Bücher, Stuttgart 1958). "Die Deutung logischer Kategorien als Spiegelung ontologischer Sachverhalte, wie Hegel sie in seiner "Wissenschaft der Logik" vollzieht, entspricht dem logisch-ontologischen Doppelaspekt der Leibniz'schen Begriffe. Die Dialektik als Umschlag der Gegensätze ineinander und als Einheit des Widersprüchlichen ist bei Leibniz in verschiedenen Formen vorweggenommen: als Lehre von den Perzeptionen, als Lehre von der Möglichkeit und dem Zusammenmöglichsein, schließlich als die komplizierte Hypothese von der prästabilierten Harmonie. So zeigt sich eine grundsätzliche Verwandtschaft der beiden Systeme, die am Anfang und Ende des deutschen Idealismus stehen." p. 138. (The interpretation of logical categories as mirror-image of ontological data, as Hegel establishes them in his "Science of Logic", corresponds with the logical-ontological double-aspect of Leibniz' terms. The dialectic as conversion of opposites into each other and the unity of the contradictorial is anticipated by Leibniz in various forms: as doctrine of the perceptions, as doctrine of possibility and co-possibility, finally as the complex hypothesis of pre-established harmony. Thus a basic relationship is displayed by the two systems which stand at the beginning and at the end of German Idealism."

49 For the provisional character of Kant's *Critique of Pure Reason* in the ontological evolution from Leibniz (via Lessing) to Hegel see Herder's "Verstand und Vernunft, eine Metakritik zur Kritik der reinen Vernunft" (1799) where Kant's insufficient understanding of the dialectic aspect of logic is pilloried. Similarly J. G. Hamann in his "Rezension".

50 J. B. Rosser and A. R. Turquette: "Many-valued Logics" (Amsterdam 1952) p. 110 f.

harsh ideological struggle finally accepted in the Soviet Union he may feel a smug satisfaction and he knows that he and his Marxist colleague now have a common subject-matter to talk about. What he mostly forgets is that the absorption of Western discoveries and theories into Soviet thinking occurs in two stages. The first stage is that the scientific material is taken over the way it is in order that the Eastern scholar may familiarize himself with it. Then the second stage follows and beyond the Iron Curtain it is considered the more important one. The theory is re-written in terms of dialectic materialism. Or at least a persistent effort is made to do so. From the conventionalistic view-point of the Western scholar this effort is irrelevant. It cannot change the subject-matter the theory is about. It only modifies its representation.

This attitude of the West European or American scholar, however, is wrong. It is, a part from the conventionalistic view-point fortified by the opinion that since the original Hegel is unacceptable as philosophic basis of, let us say, mathematical logic or quantum mechanics his re-interpretation by Marx and Lenin which does not alter the logical structure and relevancy of the system must also be unacceptable.

Two points may be made at this juncture. It is a strange spectacle to see scientists which have been trained in their own fields to cultivate an almost superhuman caution, and precision to pass judgement on a philosophic system they are admittedly ignorant of. If Lenin said of "Das Kapital" by Marx that one could not understand it unless one had studied and digested the whole logic of Hegel one might also say that no none could judge Hegel's value for modern logic, mathematics, and science unless one had read and reasonably understood the "Phänomenologie des Geistes", the "Wissenschaft der Logik", the "Enzyklopädie der philosophischen Wissenschaften" and the "Grundlinien der Philosophie des Rechts" let alone the "Vorlesungen über die Geschichte der Philosophie".

However, whether dialectic materialism as the version of Hegel's system is the philosophy of the future may remain undecided for the time being. In fact we shall, for arguments sake, assume that it provides the logician, mathematician, the natural scientist and the scholar in the social sciences and humanities with a faulty ontology. Even then it should be said that the Marxist-Leninist finds itself principally in an advantageous position compared with his Western opponent. It is an enormous help when the formation of concepts in empirical sciences is continuously confronted with general ontological criteria. Unless a dogmatism, dictated by extraneous, non-scientific interest prevails, ontological principles and particular scientific concepts will mutually correct and modify each other.

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