

Memristics: Why memristors won't change anything

Remarks to Todd Hoff's "How will memristors change everything?"

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Abstract

Memristors are first of all a hype. Even a growing hype. It didn't explode immediately but is infiltrating unstoppably all the fancy IT-magazines. A whole machinery of echoing textual productions is celebrating or denying the advent of the unknown forth element, mathematically constructed by Leon Chua for symmetry-reasons (1971) and realized physically, finally by the HP team for Information and Quantum Systems Lab under the direction of R. Stanley Williams during the year of 2008.

How could a new element, even if it is the fourth, or if it is not even an element but a class of new elements, change the world (of technology)? This blog-entry will show why such an element as it is reported in the magazines will change nothing. It will just accelerate the dimensions of what we are used to believe as guaranteed. Thus, don't read the magazines, insist on original R&D papers! For free!

1. "How will memristors change everything?"

It will sound like an echo of an echo but I will not guarantee to keep the mirrors clean. People who have better access to the original papers than myself are disseminating the narrative in all the known styles of quick defences of their established positions.

Quite late, well apologized for its retarded intervention, Todd Hoff is summarizing in a well written and entertaining survey, in the blog: *HighScalability*, nearly all points discussing the pros and cons of the new hype.

Todd Hoff, How will memristors change everything?

<http://highscalability.com/blog/2010/5/5/how-will-memristors-change-everything.html>

I will not echo this summary but will try to point to the main points of the discussion and then I hope to make it clear why all those fancy promises are not worth the excitement.

My own reading of the papers is not in the tradition of Anglo-saxon story-telling. I'm more interested in what could be called a French analysis and deconstruction of the conceptual deep-structure of the narration. Such an approach is not entertaining and therefore not easy to read. The pleasure might be in the writing, and in the chance to seduce people to enjoy

reading such analysis of the deep-structure of scientific and technological narratives, which are not specially welcomed. Some people are even afraid to get cheated by a kind of a neo-Sokalism.

Now, what are all those changes, the memristor invention/intervention will force on us in the near future?

Faster, smaller, cheaper: Without this programmed reflex to everything possibly new, nothing is working. There will be no support from academies, companies, military and post-humanists of the future of the human race, if the criteria of “*Faster, Smaller, Cheaper*” are not promised and realizations of it not guaranteed to be accessible in the near(est) future.

2. Memristors, what do we know until now?

2.1. The claims

"Let's assume for the sake of dreaming memristors do prove out."

[All citations from: Todd Hoff, How will memristors change everything?]

"I don't know, but it's worth thinking about, especially if you want to ride the wave of the next decade's technological revolution (Bell's Law of Computer Classes). If you are looking to get ahead of the next revolution this just might be it. And as almost always revolutions are based on building a new material based on a fundamental discovery of how the world works. The memristor is such a material and discovery."

"I will do a lot of 'not pretending' in this article. I won't pretend I actually understand what memristors are or how they will change everything."

2.2. The promises

It Replaces RAM, Flash and Disk

"Memristors are nano devices that remember information permanently, switch in nanoseconds, are super dense, and power efficient. That makes memristors potential replacements for DRAM, flash, and disk."

"The characteristics of memristors are such that you have to rethink the whole compute and storage paradigm. How will it change your designs if you can have large enough amounts of SRAM like storage on the microprocessor such that you don't need DRAM?"

It Requires Change

"People love progress but they hate change. Memristors require change. They are not a plug compatible technology. You can't just drop a memristor chip or RAM module into an existing system and have it work. It will take a system redesign. The question is when will the pain point in industry be sufficient to cause a migration to a new technology?"

It is Big

"How much storage are we talking about on a single chip? With an invention they hail as important as the memristor is a new architecture that allows the stacking of multiple crossbar memories on top of each other."

It Computes

"Memristors are not just stuck in they past, they don't just remember, they can perform logic!"

"But it turns out memristors naturally implement something called material implication logic, which can be interconnected to create any logical operation, much the same way NAND gates were used to build early supercomputers because they were easier to build."

"So what we have now is a material that can be dynamically configured on the fly to act as either memory or CPU."

It Flattens the CPU Memory Hierarchy Divide

"Williams claims that dynamically changing memristors between memory and logic operations constitutes a new computing paradigm enabling calculations to be performed in the same chips where data is stored, rather than in a specialized central processing unit."

It Learns

"They are also exploring the emulation of brains because the properties of the memristor apparently mimic neurons and can learn without supervision. Synapses and axons are both effectively memristors."

"The conclusion is: *Put the computation near the data.*"

2.3. The facts

It Doesn't Exist

"Yes, there's a lot of hype about memristors, but there also seems to be a lot of confidence memristors will be real viable products. But for now they don't exist." (Todd Hoff)

Strong support

That fact that DARPA is seriously engaged into memristive systems, at least with a similar engagement as they had been with the artificial neural network (ANN) movement, is a strong support to believe in the seriousness of the approach.

"The SyNAPSE Project - uses memristors in their goal of developing a petascale machine that requires no more than a kilowatt of power and two liters of space."

A similar important fact is given by the decision of HP's involvement, culminating, at the time, in the discovery/development of multi-layered crossbar memristive systems.

The other fact is, the claims are for the politicians, military and bankers, the facts of development, as much as they remain secret, are for the few scientists involved.

Not even HP's goodwill to publish their results on a level understandable for students is helping much if *Nature: International weekly journal of science* is asking US\$ 32 for the article of 3 pages.

[For free, here: <http://nature.berkeley.edu/~goster/pdfs/Memristor.pdf>]

How could it be possible to realize a paradigm shift in computing, establishing a new epoch of technology if it happens in the same elitist and exclusive way as it happened under the old paradigm of exploitation and dominance?

2.4. The concepts

"The conclusion is: *Put the computation near the data.*"

Is this anything new? Generations of systems designers and engineers have given their best to achieve this ideal.

The concept, again, is "*more of the same*".

Until now, computation was as near to the data, or the data had been put as near to the computational processors, as it is possible under the rules of microelectronics. Now we got nanoelectronics, and the distance between data and computation might naturally be reduced in a way not achievable with microelectronics.

I have the feeling that this kind of thinking for "*Faster, Smaller, Cheaper*" has lost its excitement even for bankers.

The neat hierarchy between computation and data remains untouched. What might be changed is something totally different from both: the *time* consumption in the data-transfer from storage to processor. That's for sure a great achievement if it would happen the way it is sold to the believers. It even would legitimize the propaganda of an energy saving "*Green Chip*" (Aachen/Jülich).

But again, the fundamental difference of computation (operator) and data (operands) is kept alive and is determining the rest of the game.

Therefore, if data are sitting on the top of a processor unit, and both hence, are as close together as possible, the dichotomy of "*logic and memory*" remains established and the hierarchical and static order untouched and ready for respective programming.

For people who don't want change but only the merits that's a perfect situation.

3. How to turn the hype into facts?

The best way to change the hype into facts is a double way. First, disseminate the hype. Not only on Facebook and Twitter, the name of the hype has to become ubiquitous. Second, do some serious research. Support research on all levels of accessibility. Tell the politicians that memristors are the Green Solution they are looking for.

Memristics, i.e. the study of memristive systems, is still confronted with two main conceptual and technical challenges. One seems to be well known, the other remains uncovered.

3.1. Problem of self-referentiality

What is well known, albeit not solved, and studied mainly in other disciplines, like logic or cybernetics, is the *problem of self-referentiality* of second-order concepts defining memristive systems.

Self-referentiality occurs in many forms, as circularity, chiasm, proemiality or simply as superposition of formulas of different kind, like linear and non-linear formulas, e.g for the interaction of 'logic and memory'. Logical, ontological but also technical problems of the interchangeability of the roles of a memristor as a memory or as a logic are not yet conceived properly.

The problem of self-referentiality is in fact a surface problem. Its deep-structure is heavily involved with the concept of semiotic, logical and ontological identity.

It seems that there are no working concepts in complex systems theory or in chaos theory, to deal with self-referentiality in a constructive and consistent way.

3.2. The localization problem

The second problem is more or less unknown to in the community of computer science and computer technology. It is the *problem of the localization of conceptual patterns*. This problem seems not to exist in the literature of computation and realization of computational devices. There are voices pointing to the fact that "*Simulations don't become realizations*" (Pattee) but that's all you get.

On the other side, Jianhua Yang from HP, makes it very clear: Until now, computers are *simulating* learning, it is the program that tells computers to learn, computers itself are not learning. With memristive technology things are radically different: It is the *computing matter*, the computer hardware, which is learning.

"Any learning a computer displays today is the result of software," says Yang. "What we're talking about is the computer itself - the hardware - being able to learn."

http://www.hpl.hp.com/news/2008/apr-jun/engineering_memristor.html

The learning matter (or the materiality of learning) is not a bowl of porridge. The 'materiality of learning' has its own time/space-structure. Hence any behavioral pattern, like a logical implication, in such a system is marked by the place it takes. Any design of a 'cognitive' pattern in a memristive system has to be addressed by the place it takes. The structural laws are designed by the memristive matter and not by a program of a theoretical formal system from the outside.

I might dare to predict that there will be no such radical development as it was stipulated by Todd Hoff "*How will memristors change everything?*" if the two challenges are not brought to a working (re)solution.

Memristive systems theory still lacks an understanding of the diamond structure of the behavior of memristors and it lacks too a theory of the positionality of memristive behaviors. In short, what is needed, at least, is a *diamond theory* and a theory of *place-designators* for self-referential and located behaviors in memristive systems. It is one of the aims of a proposed

memristics to deliver a conceptual model and formal apparatus to deal with diamond (chiastic, circular, proemial) behaviors and the mechanisms of localizations suitable for memristive systems.

Further reading:

[http://www.thinkartlab.com/pkl/lola/Memristics/Memristics:Memristors, again.pdf](http://www.thinkartlab.com/pkl/lola/Memristics/Memristics:Memristors,_again.pdf)

<http://www.thinkartlab.com/pkl/lola/Memristics/Part-II/Memristics-crossbar.pdf>