

**A few notes on
Evelyn Fox Keller on
Organisms, Machines, and Thunderstorms:
A History of Self-Organization**

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A survey by Evelyn Fox Keller

After I had written most of a draft (in 2014/5) paper on the role of Evolved Construction Kits in biological evolution, especially evolution of information processing systems, I came across a very relevant two part survey paper by Evelyn Fox Keller (MIT) Published in *Historical Studies in the Natural Sciences*, Vol. 38, No. 1 (Winter 2008), pp. 45-75 and Vol. 39, No. 1 (Winter 2009), pp. 1-31 Organisms, Machines, and Thunderstorms: A History of Self-Organization, Part One Organisms, Machines, and Thunderstorms: A History of Self-Organization, Part Two: Complexity, Emergence, and Stable Attractors

Here are some extracts from Part 2:

"Yet it remains the case that no one has succeeded in doing for biology what Newton did for physics: construct a satisfying account either of the origin of life or of its organization, in terms that can be laid out in a few graspable equations."

"There may not be any consensus about the best terms in which to describe the organized complexity exemplified by living organisms, but the challenge has been clearly laid out. Also, it remains uncertain just what kind of explanation the most sophisticated models coming out of systems biology might yield--whether, for instance, such explanations will fall within the range of human reason, graspable by our cognitive capacities, or whether they will require reliance on computers that are so much better at handling complexity than we are. But that is another question altogether. Perhaps, in the end, if and when we succeed in explaining just what it is that is so distinctive about biological entities, Kant will have been proven right--right, that is, about the relation between such accounts and the capacities of human judgement."

She refers to work of Walter Fontana and Leo Buss, who conclude that "The traditional theory of 'dynamical systems' is not equipped for dealing with constructive processes". I think that is a serious understatement! What they claim is required is an "...effort to expand the traditional theory to include objects, their internal properties, their construction, and their dynamics", i.e. a theory of "*Constructive dynamical systems*".

My paper on construction kits (reference below) goes beyond that to require both evolution and development to be capable of creating not only new objects, but also multiple (branching) layers of new construction kits that enrich the variety and complexity of objects that can be constructed, the processes that can occur in them (e.g. developmental, learning, communicating, and problem solving processes) and the behaviours that can be produced as a result, including interactions with structured objects of many types, in the environment, including other organisms.

Moreover the theory claims not only that new construction kits can extend the types of organism that are produced by biological evolution, but also that construction kits are produced (by second-order, or meta-construction kits) during development of individual organisms. I.e. instead of the genome having to specify construction [processes](#) for every component and every function of the organism with that genome, genomes can instead specify construction [kits](#) that can be invoked during development to create components, and the details of the construction kits may be influenced by results of earlier constructions or sensed features of the environment during development of the organism.

A spectacular example in humans is the development of a multi-level collection of construction kits for aspects of language where at each level the construction process can be influenced by both the current environment and the products of construction kits that were active at earlier stages. This is what we call a Meta-Configured Genome (MCG), explained in more detail here:

<http://www.cs.bham.ac.uk/research/projects/cogaff/movies/meta-config/>

This work is part of the Turing-inspired Meta-Morphogenesis project:

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/meta-morphogenesis.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/meta-morphogenesis.pdf>

Note added: 14 Apr 2024

A recent major extension of that project, including discussing mechanisms of evolution, development, and reproduction, including amazing processes of metamorphosis of insects in cocoons or pupas, can be found in this huge and still growing document (work in progress):

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/meta-morphogenesis.html>

To be continued ... possibly ...

REFERENCES

Construction kits required for biological evolution

(Including evolution of minds and mathematical abilities.)

The scientific/metaphysical explanatory role of construction kits

The paper on Evolved Construction Kits is available here:

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/construction-kits.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/construction-kits.pdf>

Comments, criticisms, suggestions, all welcome.

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