

Fundamentals of Holonic Systems and their Implications for Self-adaptive and Self-organizing Systems

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Introduction

- Multidisciplinary R&D :
 - Holonic Systems
 - SASO
 - SASO is well-known
 - Holonics is (completely) unknown
- Presentation about ...

Monodisciplinary R&D

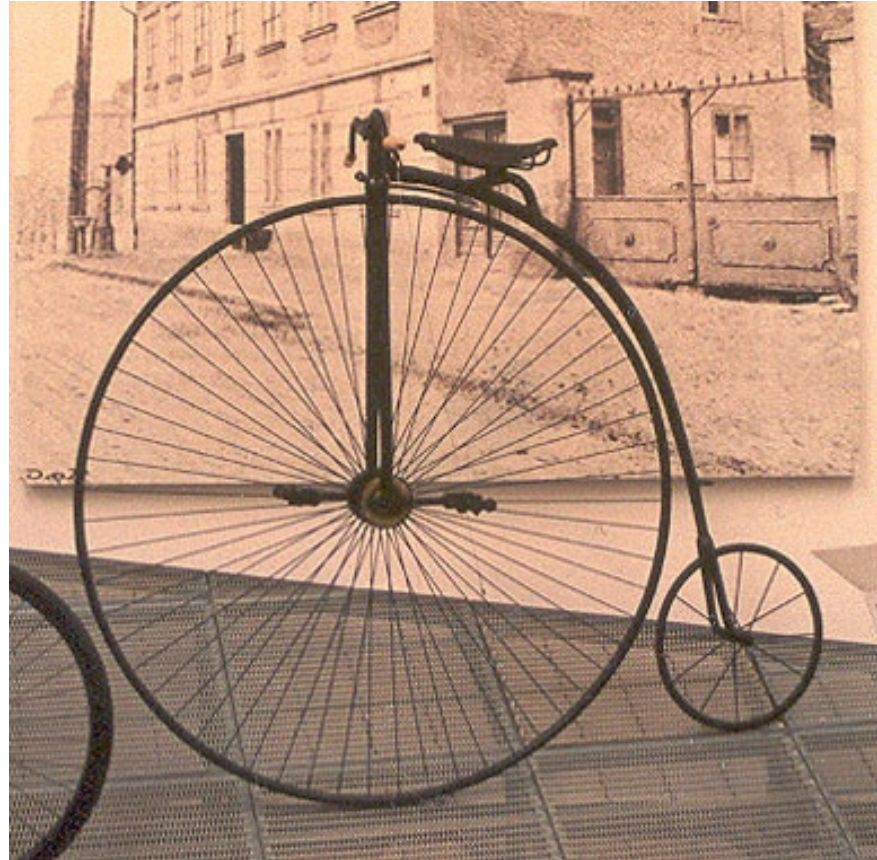


Monodisciplinary: technology transfer

John Doe, Mary Stone, (2006): *Softening the steep learning curve of monocycles in industry*, Int. J. of ...

Failed attempts to multidisciplinary R&D

- Known for its braking problems.
- The cyclist is unable to lean backward and therefore s/he is unable to execute the well-known braking manoeuvre describe in a landmark paper by Michel X and Nick Y.



Multidisciplinary results : rejected



- Rejected at all conferences because “no tubes”
- John Doe lobbies to “tighten” the slalom benchmark

What society needs and never gets



Multi-disciplinary Research

- Overspecialisation is a fact-of-life
- Few multidisciplinary results = bad
- Failure to appreciate = much worse
 - Dangerous to our society
 - Aristotle's contribution to astronomy !
 - Greek society and culture was about to decay into oblivion.

Holonics 101: H. Simon

- There were once two watchmakers, named Hora and Tempus, who made very fine watches. Both were highly regarded, and the phones in their workshops rang often—new customers ordering watches all the time. However, while Hora prospered, Tempus became poorer and poorer and finally lost his shop. What happened?

Holonics 101: H. Simon

- The watches consisted of about 1000 parts each. Whenever the phone rang and Tempus had to put down a partly assembled watch, it immediately fell to pieces and its assembly had to restart from the elements. The better customers liked his watches, the more his phone rang, and the less watches could be produced.

Holonics 101: H. Simon

- Hora's watches were equally complex, but she had designed them so that she could make subassemblies of about ten elements. Ten of these subassemblies form a larger subassembly; and a system of ten large subassemblies constitutes the whole watch. Thus, when Hora had to put down a subassembly to answer the phone, she only lost a small part of her work.

Holonics 101: H. Simon

- **In demanding and dynamic environments, all successful complex adaptive systems are “holonic”** (pyramidal, hierarchical, etc.)
 - A law of the artificial
- Adaptation thru subsystem replacement
- Subsystems emerge and persist
- Which subsystems ? Already there ?

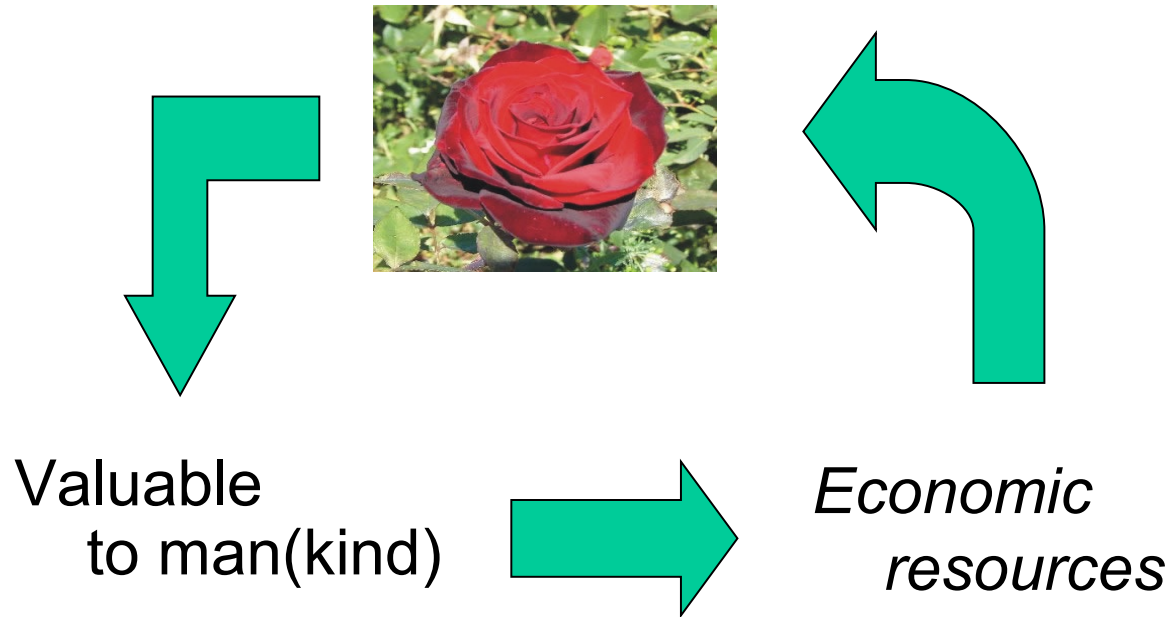
Autocatalytic sets

- An attempt to rely on Darwin to explain the emergence of life
 - Life >> complex system
 - Emergence >> limited rationality
 - Not plausible
- If by chance a small set of components is formed that are a catalyst to themselves
 - Plausible
 - Empirical evidence: rabbits, weeds, ...

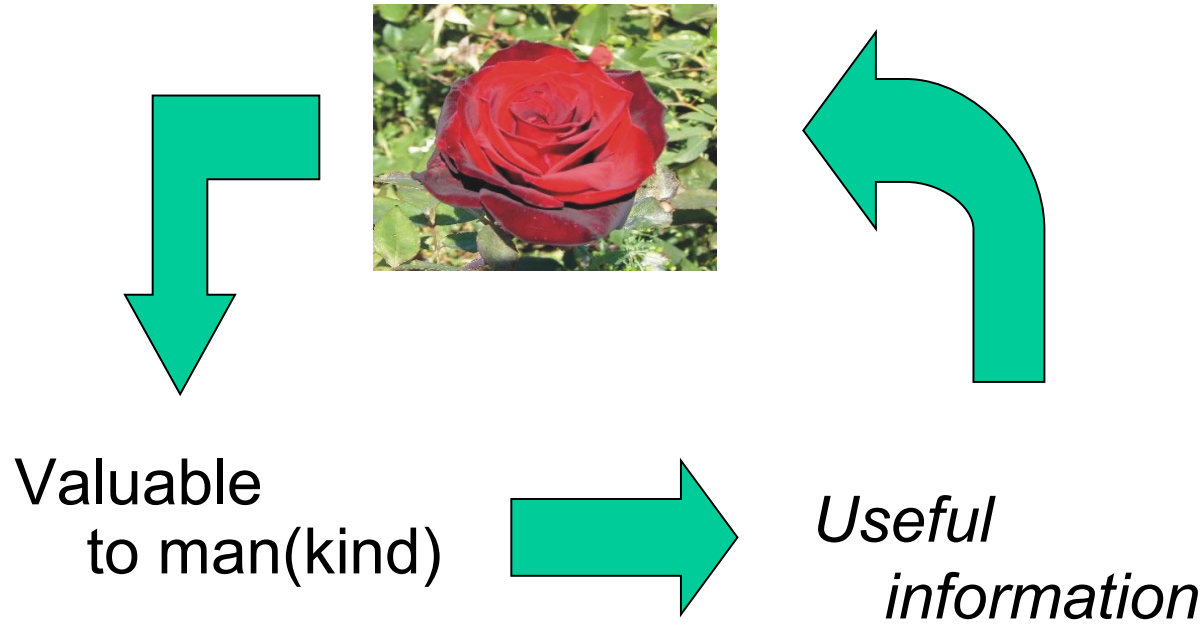
Which autocatalytic set for artifacts?



Which autocatalytic set for artifacts?



Which autocatalytic set for artifacts?



Which subsystems ?

- Already existing >> autocatalysis
 - Autonomy
- Seeking to improve their autocatalysis
 - Cooperativeness
- R&D designs must maximise the potential for autocatalysis
- R&D designs must maximise the potential for cooperativeness >> shield from...

Which subsystems & SASO

- R&D designs must maximise the potential for autocatalysis
 - SASO enlarges scope/range/...
- R&D designs must maximise the potential for cooperativeness >> shield from...
 - SASO reduces mutual demands
- Paper discusses HMES that complies with the above.
 - *MES cooperates with scheduler*

Non-holonic elements

- Is the water in the oceans a holonic system?
- Its complexity and adaptiveness require little information processing
 - It “copies” from its surroundings
- Maps
- Intelligent beings

The Newfoundland Anecdote

Transcript of a radio conversation released on 10-10-95

Canadians: "Please divert your course 15° to the South to avoid a collision."

Americans: "Please divert your course 15° to the North to avoid a collision."

Canadians: "We Repeat. Recommend you divert YOUR course 15 degrees to the South to avoid a collision."

Americans: "This is the captain of a US Navy ship. I say again, divert YOUR course."

Canadians: "No, I say again, you divert YOUR course."

The Newfoundland Anecdote

Transcript of a radio conversation (continued):

Canadians: "No, I say again, you divert YOUR course."

Americans: "THIS IS THE AIRCRAFT CARRIER USS ABRAHAM LINCOLN, THE SECOND LARGEST SHIP IN THE UNITED STATES' ATLANTIC FLEET. WE ARE ACCOMPANIED BY THREE DESTROYERS, THREE CRUISERS AND NUMEROUS SUPPORT VESSELS. I DEMAND THAT YOU CHANGE YOUR COURSE 15 DEGREES NORTH. THAT'S ONE-FIVE DEGREES NORTH, OR COUNTER MEASURES WILL BE UNDERTAKEN TO ENSURE THE SAFETY OF THIS SHIP."

Canadians: "This is a lighthouse. Your call."

Intelligent Being – Intelligent Agent

- US Navy >> Intelligent agent
- Canadian lighthouse >> Intelligent being
- Solving the conflict leaves the intelligent being intact!
- In fact, the captain continues his course since he will be airlifted from the ship and replaced before the ship runs aground, and his bonus depends on the distance to the final destination along the shortest route through the air. He orders the lighthouse to be destroyed as to eliminate all traces of his suboptimal decision (to safeguard his personal income)

Conclusions

- SASO community lacks knowledge from other relevant disciplines
 - Holonics is very relevant
 - SASO fails to appreciate Simon's perspective (i.e. the definition of complex-adaptive), and fails to recognise why Simon's viewpoint is valid indeed.
- Impact:
 - which SASO-systems to design and build
- Non-holonic artefacts
 - make sense but have their own rules (e.g. I-Beings)
- Do not expect multidisciplinary R&D to improve on the state-of-the-art in your own discipline.
It has a more profound impact (e.g. on John & Mary).