Complexity Perspectives in Innovation and Social Change

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The message

- We must innovate to create a sustainable society
- The threat to sustainability is the result of innovation
- Can we find a way out of this dilemma?
- Yes, but only if we innovate differently!
  - We need to harness innovation rather than live with its results
  - We need to know more about innovation …
  - We need to know more about sustainability …
- How do we manage the change?

We are living in a complex adaptive system…

- The Earth system is a complex adaptive system
- Society is an integral part of it
- Such systems are characterized by
  - High dimensionality
  - Multiple attractors
  - Open-ended trajectories
  - Tipping points and unstable phases
  - Absence of long-term predictability
  - …

Every society is an information society

- Information processing is the driver of societal dynamics
  - In contrast to energy and matter, information is not subject to the conservation principle: as neg-entropy, it can spread
- Societies are not held together by the matter they exchange, but by the ideas they share
  - Information is the enabler, energy the constraint
- Human societies harness necessary energy by transforming the organization of their environment
  - They dis–embed from the environment to control it

Our cognitive capacity is limited

- Human STWM limited to 6 ± 2 dimensions
- We have managed to 'deal with' the CAS we are part of, but we do not 'know' it
  - Our ideas under-determined by our observations
- Reductionist scientific approach focuses on causality through observation-validation cycle
  - It fragments our perspective
  - It focuses on explaining the past, rather than anticipating the future
- To deal with complexity, we bring larger and larger groups together
  - Communication categorizes and simplifies, reducing dimensionality of phenomena

… and we know less and less

- Our actions lead to unintended consequences
  - They result in increases in dimensionality
  - Shift in risk spectrum to longer, unknown timescales
- Over the longer term, our knowledge grows linearly or at best geometrically
- The unintended consequences of our actions grow exponentially
- This leads to inevitable crises
  - Time-bombs; Black swans; Risk barriers
  - Challenges outweigh potential solutions
- Crises are temporary incapacities of a society to process the information needed to deal with the world

This is where we are now

- There seem to be several crises:
  - Environmental, financial, social
- In reality there is one crisis: our societies' information processing apparatus is now insufficient to deal with the dynamics of our surroundings
  - Their dimensionality has exploded on us
- The situation is so complex that we play 'panic football'
  - Short-term tactical decisions (innovations) come to dominate
  - We lose sight of long-term strategy (sustainability)
- And in so doing, we further aggravate the situation

The long term of sustainability

- Innovation shifts risk spectrum, creates unknown longer-term risks in environment
  - Unintended consequences
  - Time-bombs
- Throughout history, this *locally* threatened sustainability, but was dealt with because
  - Migration always allowed a new beginning
  - There was a built-in control on innovation: was it useful?
- Neither is available now

Innovation between supply and demand

- Invention is about implementing a bright idea
- Innovation is about matching supply and demand so that the invention spreads
  - Until the 1800's innovation demand-driven: how to find a use for a brilliant idea?
  - Nowadays innovation supply-driven: how do we adapt society to that brilliant idea?
- Western society has become innovation-dependent
  - Absence of self-regulatory mechanism
  - Innovation accelerates exponentially
- Linear approximations inappropriate to study innovation
  - Complex adaptive systems approach called for

Endemic 'wild' innovation

- Up to 17th cty: innovation seen as 'bad'
- Now seen as (the ultimate) 'good'
- We invest in innovation for its own sake
  - Not knowing how it works
  - Not knowing what it will do
- There is a lot of waste in investment and result
- 'Wild' innovation threatens sustainability
- We need to focus innovation on achieving sustainability!
- We need to understand innovation and define sustainability
  - Can innovation be circumscribed and/or anticipated?
  - Can its environmental impact be limited?

How to attain sustainability?

- Develop an 'a posteriori' perspective, working back from our vision of the future to what to do in the present
  - Become pro-active rather than re-active
  - What kind of future will be sustainable?
    - This is the hard question of societal choice, not science
  - What do we need to know to achieve it?
    - What is the missing knowledge and how do we acquire it?
  - Which strategies need to be implemented?
    - How do we decide between them?
  - What is needed for their implementation?
    - Where do we need to innovate?
  - How do we educate people about them?

How do we innovate?

- We don't know!
  - In reductionist science, it is a non-scientific topic
  - We have only used a posteriori indicators
  - We have looked for the key under the streetlamp
- Develop a generative ('a-priori') perspective
  - How does innovation happen?
  - How does one become innovative?
  - How does one create a culture of innovation?
- Evaluate role and consequences for innovation and sustainability of choices made against those not made
  - Building and evaluating multiple scenarios
  - Simulation, fore- and back-casting as continuous process

Challenge 1: Generalized ICT

- Use ICT to reintegrate society in a different way
  - Current political crises across all democracies a warning sign!
  - Replace top-down vs. bottom up with an interactive system
  - Replace polls and surveys by continuous real-time monitoring
  - Reduce time delays in interaction
- Further integrate instrumental and social information-processing and decision-making
  - Introduce computational thinking everywhere in society
  - Introduce generalized information processing thinking about society in computer science

Challenge 2: Overcoming our cognitive limitations

- Overcome the under-determination of our ideas by our observations
  - Massive ICT real-time data gathering is capable of doing it
- Overcome the limitations of human STWM
  - Generalized ICT to go back and forth between reducing and increasing dimensionality in an explicit way
  - New ontologies, new mathematics, new software
  - Integrate forecasting and backcasting
- Overcome the limitations of our thinking
  - Combine ex-post *and* ex-ante approaches in science
  - From disciplines to intellectual fusion
  - Use-inspired research between 'blue skies' and 'applied'

Challenge 3: Emergence by design

- Fundamentally different way of dealing with up-scaling communication to promote social coherence
  - Interactivity between top-down and bottom-up
- Ideas, opinions and inventions are rampant, both on supply and demand side
  - Continuously monitor both in cyberspace in real-time
- Select high-demand inventive ideas aligned with sustainability
  - Identify or create scaffolding structures in cyberspace and develop them
- Achieve quick response to demand, beginning with low-hanging fruit

Challenge 4: Unintended consequences

- Outcomes of social (and socio-environmental) innovations cannot be anticipated, even in the short term
  - Too many stakeholders and actors with different perceptions and actions
- Complex systems are unpredictable in the long-term
  - Dynamic CAS models improve short-term prediction of immediate consequences
  - Much work is being done on the dynamics of these systems
- Use Agent-Based Modeling as basis
  - Relational logic on branching space-time concept (Belnap et al.)
  - Include feed-forward alongside feedback (J.S. Nicolis)
- Develop decision-making under uncertainty research