

# Goedel and the Schrodinger-Heisenberg Railway: Exploring Unknowability and Undecidability

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# Goedel and the Schrodinger-Heisenberg Railway

- Exploring Unknowability and Undecidability
- An Incompleteness Theorem
- An Uncertainty Principle
- A Thought Experiment
- The Schrodinger-Heisenberg Railway
- The Limits to Bureaucracy
- A Systems View

# Goedel's Incompleteness Theorem

- Theorem of Undecidability, which showed that within the limits of any formal language or system of logic, some propositions are "undecidable"
  - [https://academic.oup.com > book > 40753](https://academic.oup.com/book/40753)
  - Kurt Goedel (1927)
- Russell's Set Theory Paradox (1901)
  - The Barber
  - <https://www.britannica.com/topic/Russells-paradox>

# Schrodinger's Cat

- A cat is locked in a steel box with a small amount of a radioactive substance such that after one hour there is an equal probability of one atom either decaying or not decaying. If the atom decays, a device smashes a vial of poisonous gas, killing the cat. However, until the box is opened and the probabilities are resolved the cat is in a superposition of two states: it is both alive and dead.
  - <https://www.britannica.com/biography/Erwin-Schrodinger#ref1229301>
- So what?
- Certainties are dependent on probabilistic events and are always history?

# Heisenberg: The Uncertainty Principle

- We can know where something is or how fast it is changing, not both
  - Effect of the observer on the observed
- A similar uncertainty principle also applies to problems in pure math and classical physics
  - The act of measurement changes what is measured
  - <https://scienceexchange.caltech.edu/topics/quantum-science-explained/uncertainty-principle>
- So what?
- Certainties are dependent on probabilistic events and are always history?

# The Schrodinger- Heisenberg Railway

- The UK railway appears to answer to classical rather than quantum laws, or does it?
  - We manage it as an enormous and enormously complex machine
    - 20000 miles long (all rails end to end) and about 30 yards wide
    - 100,000 human actors
    - Millions of journeys
  - It is comprised or composed of millions, perhaps billions, of richly interconnected elements
  - Meanwhile it displays ‘action at a distance’ to itself and its environment
    - Transmission of noise, heat, vibration (hidden variables?)
    - Changing one part changes others – transmission of stress?



- We can either know what condition the railway is in
  - OR
- We can know how quickly we are wearing it out
- We cannot know both.....
- Every time we drive a train down the tracks its availability is a function of collapsing probabilities
- The only thing we can know to a certainty is that it was 'ok' last time we used it
- So what?

## The Bureaucracy- Uncertainty Paradox

- We manage the railway as a finite, mechanical device with all the certainties offered by Sir Isaac Newton
- BUT
- Management relies on a bureaucratic control structure
- Beliefs about its condition are supported by high latency information flows
- Decisions are of necessity judgement based
- BUT
- We hold individuals to account against the Newtonian certainties

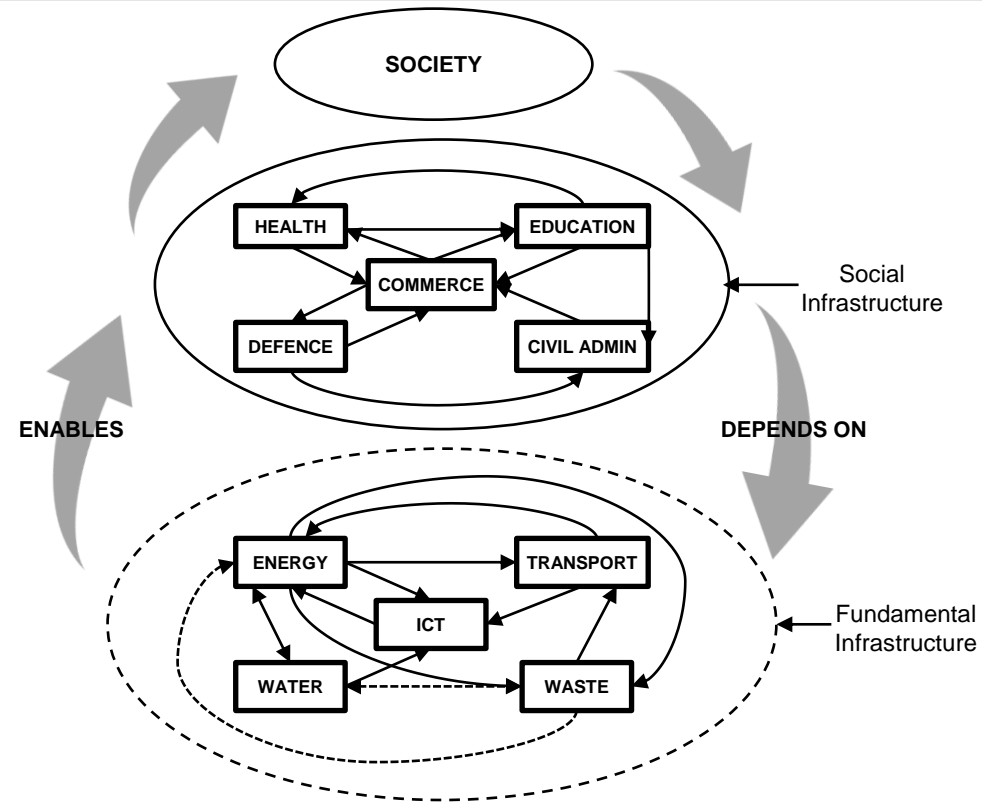
- “Organisations have the choice between bureaucracy and dillettantism”
  - Weber, 1923
- A formal system of impersonal offices, authority attaching to the office not the individual,
  - Standards, systems, processes to ‘guarantee’ availability
  - Delusion of Stability
  - Assume a finite solution

- A bureaucracy is the realisation of the formal logical language of large scale organisations
  - While it is the formal language of organisation
    - It is necessarily incomplete
    - It therefore generates undecidable propositions
  - “However long we make the process chart we never quite reach the customer” (Dudley, 1998)
- The Incompleteness Theorem suggests to us that we cannot create a finite solution

- A bureau...  
language...
    - Is th...
    - It is ...
    - It co...
    - “How...
    - reac...
- “A model is neither true nor false, it is more or less useful”**  
**Stafford Beer, Diagnosing the System, Wiley, 1985**
- The Incompleteness Theorem suggests to us that we cannot create a finite solution

- Bureaucratic thinking imposes fragmentation, limitation
- BUT
- The challenges we address as infrastructure systems leaders are not infrastructure issues
- They are political, societal, economic, challenges of meeting human needs, wants, desires not engineering specifications!

# Infrastructure Sub-Systems



**So!**  
**A Different Perspective**



- “Nature did not invent disciplines, man did”
  - Misquoting Checkland, 1981
- **Interaction & Interdependence**
  - The idea of ‘system’ is rooted in the connectivity of one element with others – this system must be dealt with in its totality
    - The functioning of one element of the infrastructure depends on one (or more) other elements
    - Issues cannot be resolved in isolation
- **Probabilism & Self-Organisation**
  - The behaviour of a (dynamic) system is neither deterministic nor linear
  - It will be self-organising to some degree, its dynamics and connectivity will drive what it does
- **Emergence**
  - Systems exhibit properties that belong only to the system – not to any of its elements
- These characteristics make ‘systems’ hard to comprehend and manage – so we must address them with a systemic mindset

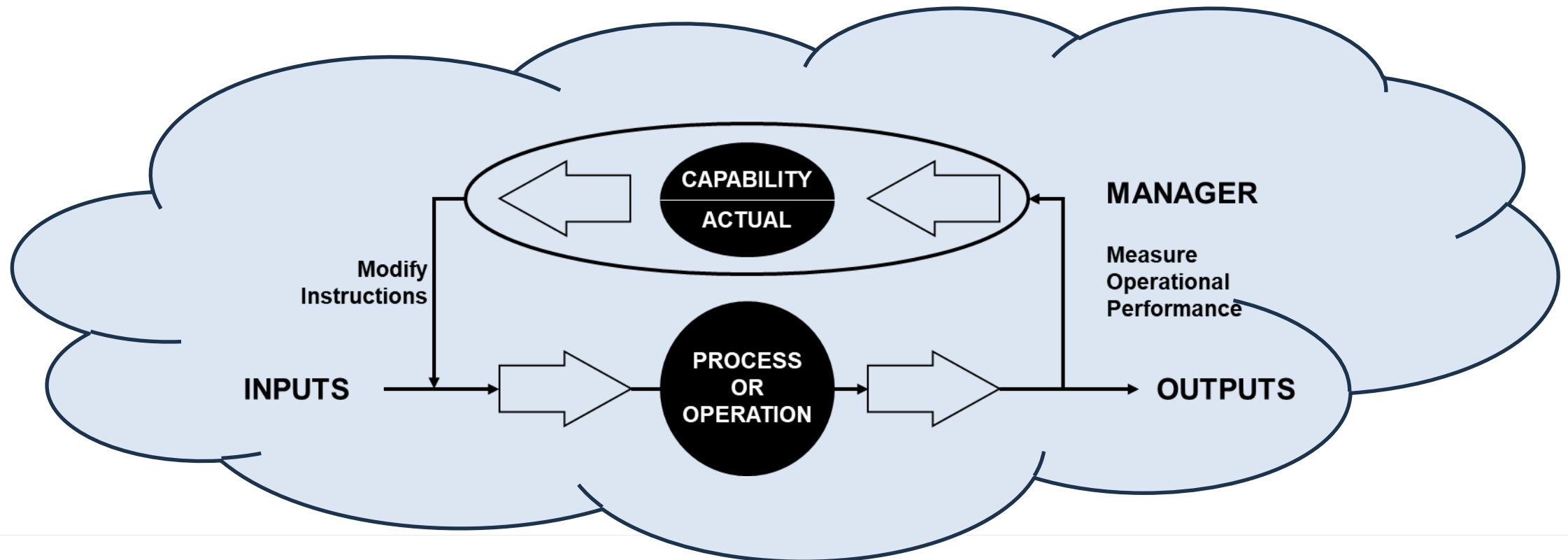
- Emergence? What is that?
- A system taken AS a system displays properties that cannot be found in any of the parts, they depend on systemic interactions
  - A journey on a train
  - Flight in an aircraft
  - Walking in a human being
  - Thinking.....
- Sclerotic Bureaucracy in a University?
  - It is never intended that way, it is a product of the interactions....

## So! A Different Perspective

- Problems, opportunities challenges are dealt with as wholes
- Integration not fragmentation
- Multi-dimensional problems that must be (re)solved simultaneously
- Not about analysis but about synthesis
- Change in one part stimulates or causes change in other parts
  - Elements are not just inter-connected but interdependent
  - Addressing situations of dynamic complexity
- Situations are infinite and evolving?

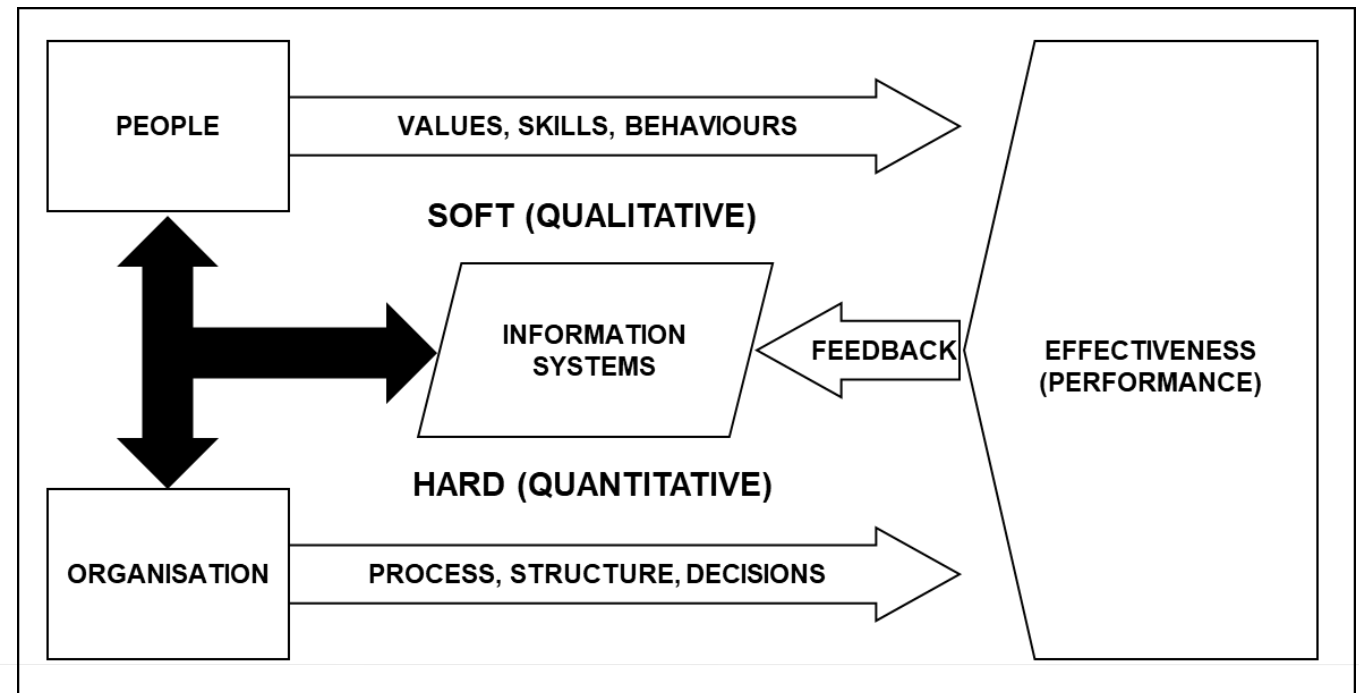
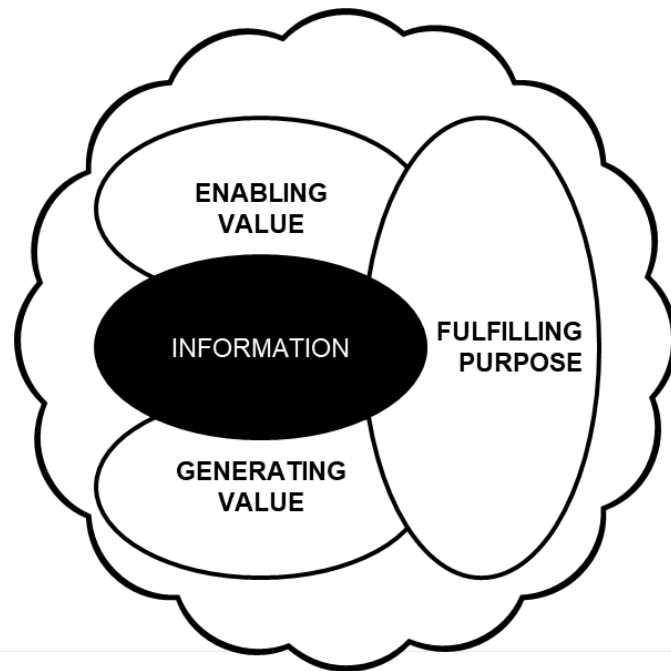
# Core Idea of Cybernetics: The Homeostat

- Self-regulation, adaptation, stability, learning
- Complexity emerging from interactions

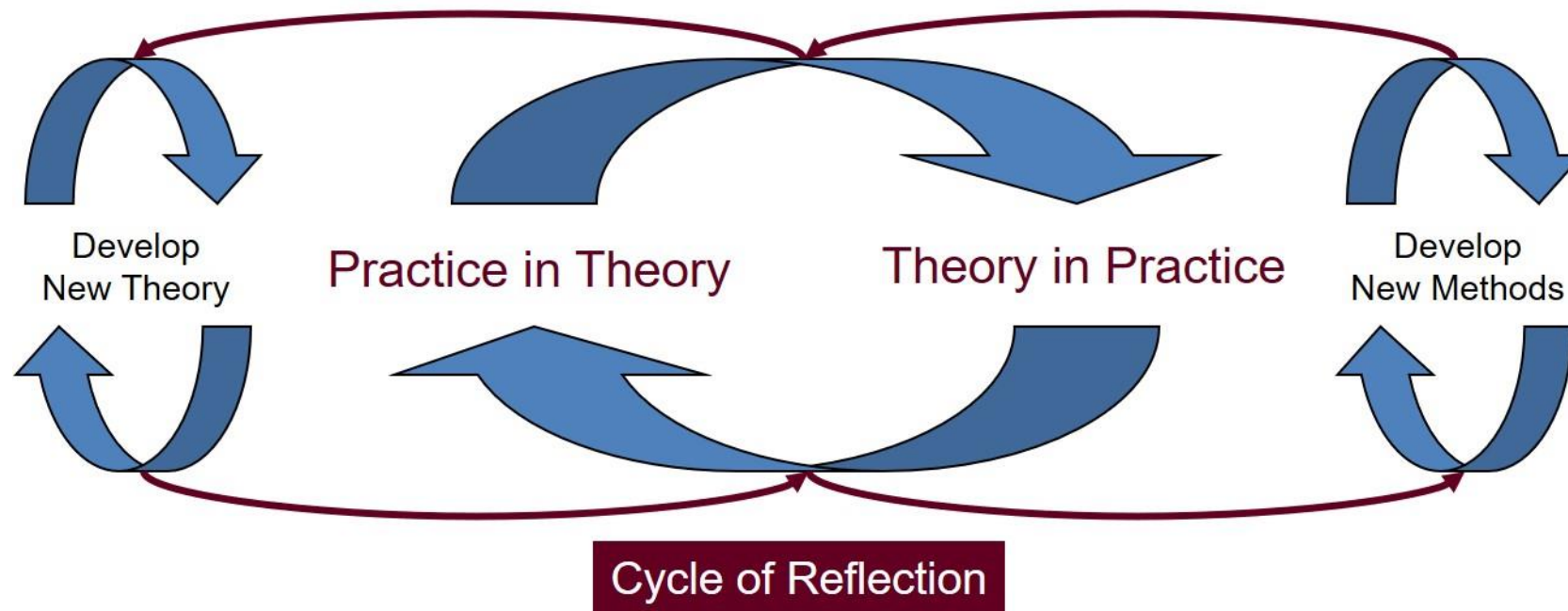


# Allostatic Organisation: Dynamic Stability

- Stability is an emergent property of a dynamical system, the transition to exploitation of digital capability must be complemented by a transition to adaptiveness as the basis of organisation.



Continuous adaptation!



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# "Have Highway Engineers reached the end of the road?"

Andreas Markides  
Markides Associates

23 November