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Soft Engineering: anticipating an increasingly messy landscape for engineering practice

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Engineering and anticipation….

- national infrastructure projects
- infrastructure interdependency
- energy – security, planning, efficiency…
- transportation
- waste prevention
- cyber security
- smart/future cities
- autonomous vehicles
- large ICT procurement
- defence materiel
- water resource management
- flood defences
- air quality
- new nuclear
- …

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Examples of problematic engineering projects

- National Programme for IT in the NHS
  - Project failure (£10Bn) http://goo.gl/xt5ixd
- BBC Digital Media Initiative
  - Project failure (£98M) http://goo.gl/pYF0WZ
- Princess Elizabeth Class Aircraft Carriers
  - Lack of aircraft for operational deployment (£5.9Bn) http://goo.gl/4X62NW
- Nimrod maritime surveilance aircraftMRA4
  - Scrapping (£4Bn) http://goo.gl/lvqd8b
- New nuclear build at Hinkley Point C
  - Issues around build cost and subsidies (£18Bn) http://goo.gl/dgUU45
- HS2 Rail Link
  - Contested business models & route (~£50Bn) http://goo.gl/kruL3X
- Volswagen
  - Diesel emissions cheating scandal (€6.7Bn in first quarter) http://goo.gl/OR8C32

"It knows that occasionally people make terrible decisions… In one recent case, a cyclist entered the intersection after a light turned green; the SUV beside the Google car nearly hit the rider, but the Lexus waited patiently because it knew what was happening. These instances, while rare, are not outside the imagination. But the car must be ready for events that fall into that category, too, especially in city settings. Dolgov described one circumstance that (correctly) puzzled the car into submission recently: it turned out to be a person in a wheelchair chasing a duck with a broomstick. In circles. In the middle of the street. "This is not something we likely would have *anticipated*," he says. "And this is not something you can very **accurately model.**""

Dmitri Dolgov, Google. http://goo.gl/43wRk1

Google's latest prototype waits to give rides on the roof of the Google-X building. (Eric Jaffe)

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http://www.bristolisopen.com

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How cities work is changing. Developments in software, hardware and telecom networks are enabling more interaction between people and places and more machine-to-machine communication, creating an internet of things. Opening-up and making sense of this will give citizens more ability to interact, work and play with their city. Smart city technologies will be able to respond in real-time to everyday events including congestion, waste management, entertainment events, e-democracy, energy supply and more. Together we will create an open programmable city region.

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CITIES & ARCHITECTURE

Beware the Posthuman Future of Smart Cities and Surveilled Beings

BY PRAMOD K. NAYAR ON 18/10/2015 • LEAVE A COMMENT

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Smart Cities might offer one set of technologically determined solutions to human and social problems but smartification may also come at a great cost to one's subjectivity as a citizen.

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http://profiles.arts.monash.edu.au/rob-sparrow/download/20-seconds-to-comply.pdf

Twenty Seconds to Comply: Autonomous Weapon Systems and the Recognition of Surrender

Robert Sparrow

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https://goo.gl/D4qxkN

the ONION | Wall Street Firm Develops New High-Speed Algorithm Capable Of Performing Over 10,000 Ethical Violations Per Second

Wall Street Firm Develops New High-Speed Algorithm Capable Of Performing Over 10,000 Ethical Violations Per Second

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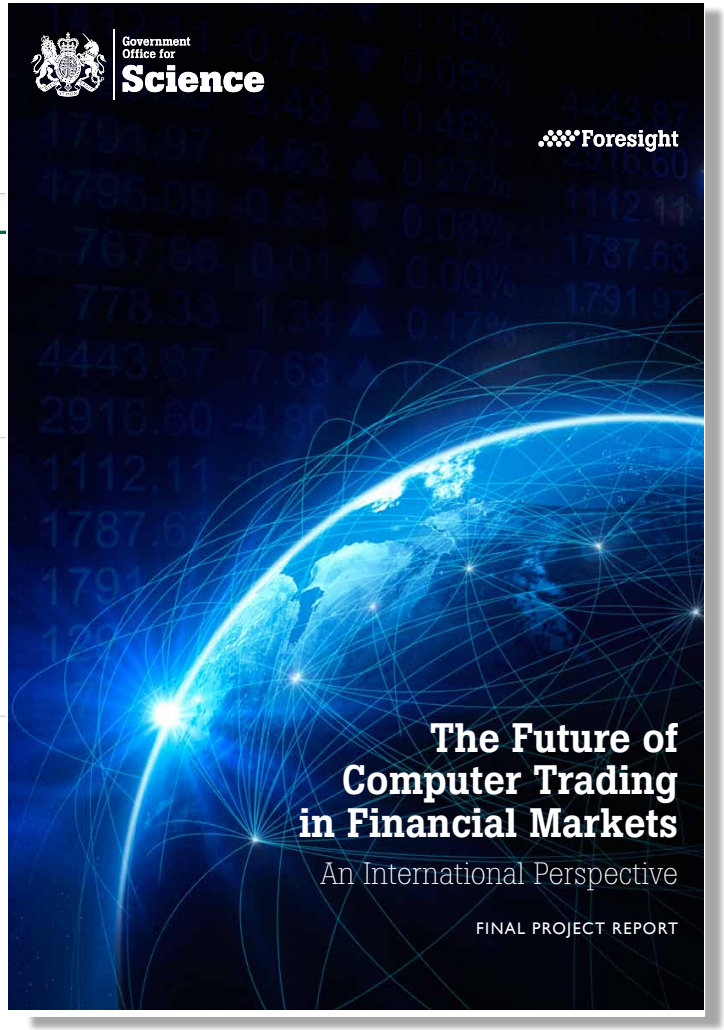

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Better Systems Engineering?

- convened by IFSR with INCOSE Systems Science Working Group (SSWG) and International Society for the Systems Sciences (ISSS) joint sponsorship
- continued development of the Systems Praxis Framework (SPF)
- focussed on developing
  - pragmatic framing of Systems Engineering within its wider context
  - theoretical foundations for SE

http://goo.gl/FRHSOe

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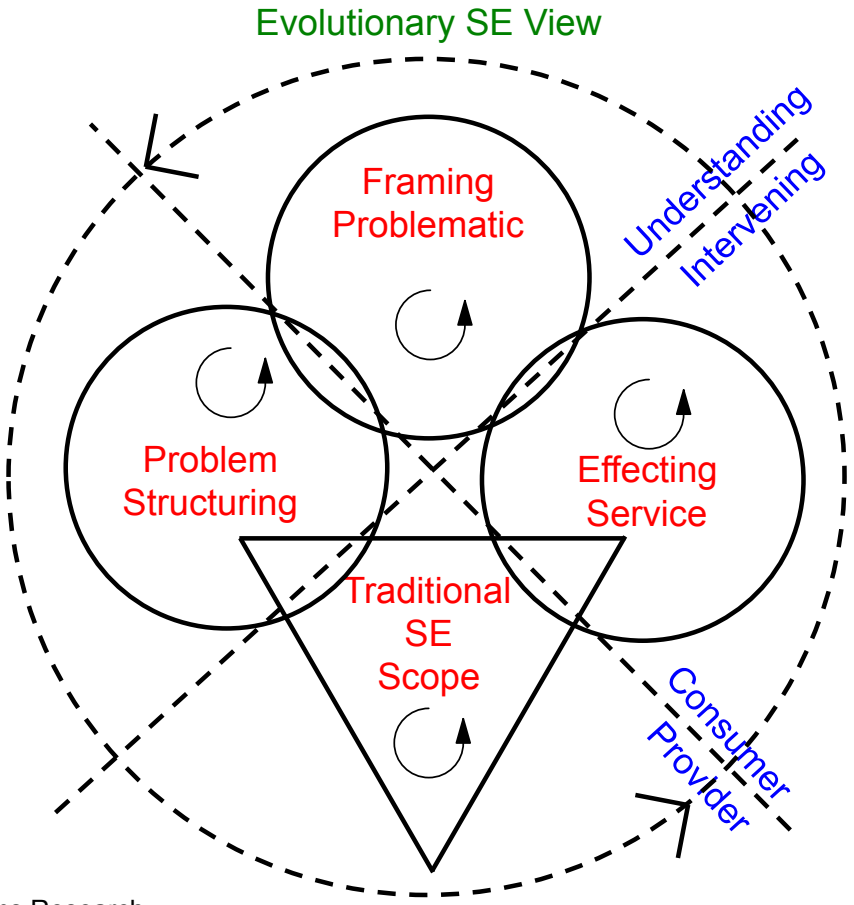
(Yearworth, Willis Singer et al., 2015)

Systems Engineering in a context of systemic cooperation (SCOOPs)



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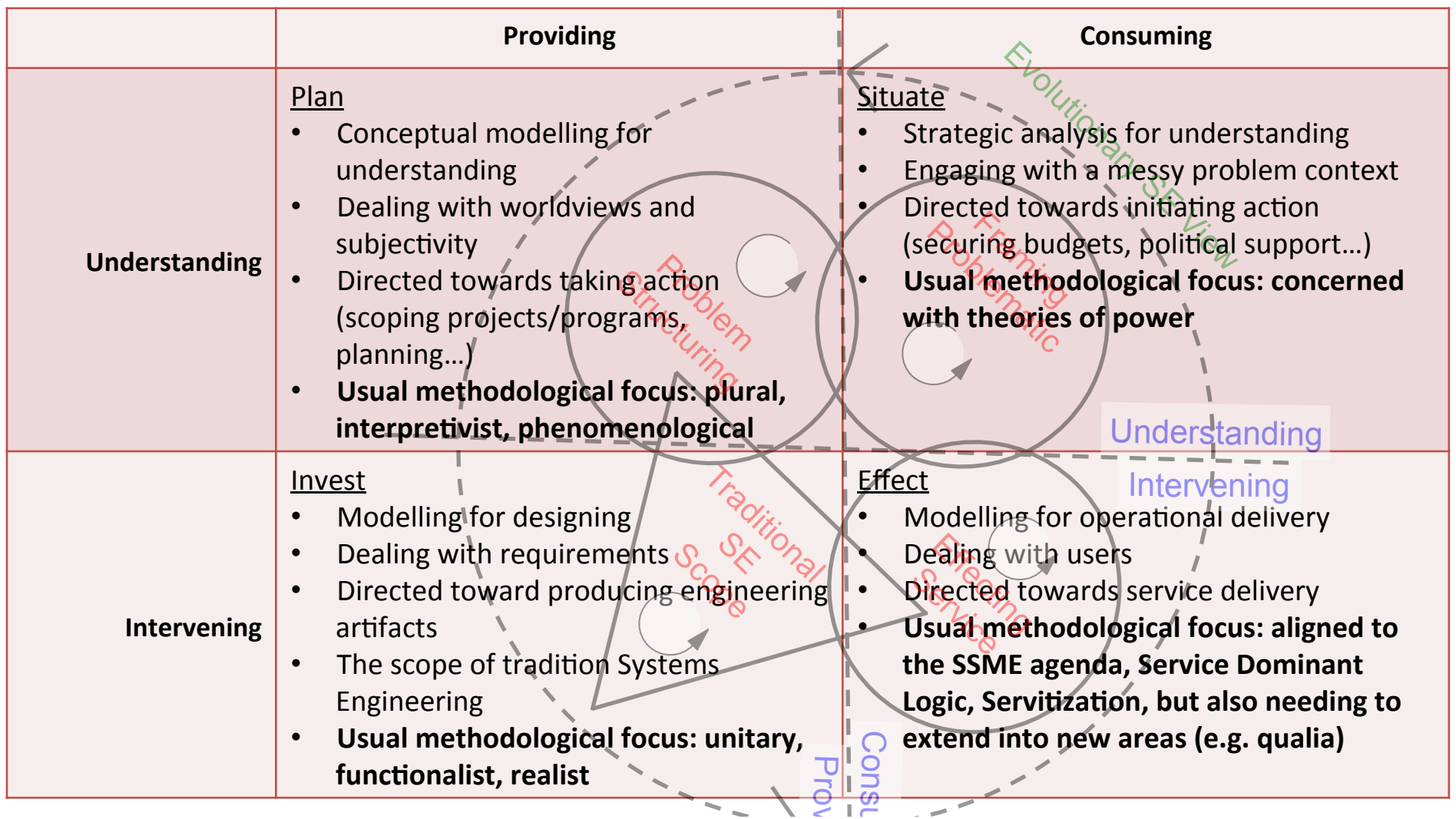
(Yearworth, Willis Singer et al., 2015)

Better Systems Engineering?

	Providing	Consuming
Understanding	Plan • Conceptual modelling for understanding • Dealing with worldviews and subjectivity • Directed towards taking action (scoping projects/programs, planning…) • **Usual methodological focus: plural, interpretivist, phenomenological**	Situate • Strategic analysis for understanding • Engaging with a messy problem context • Directed towards initiating action (securing budgets, political support…) • **Usual methodological focus: concerned with theories of power**
Intervening	Invest • Modelling for designing • Dealing with requirements • Directed toward producing engineering artifacts • The scope of tradition Systems Engineering • **Usual methodological focus: unitary, functionalist, realist**	Effect • Modelling for operational delivery • Dealing with users • Directed towards service delivery • **Usual methodological focus: aligned to the SSME agenda, Service Dominant Logic, Servitization, but also needing to extend into new areas (e.g. qualia)**



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(Yearworth, Willis Singer et al., 2015)

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Adapted from (Checkland & Holwell, 2004)

The manufactured divide of hard/soft paradigms

Hard Systems Thinking	Soft Systems Thinking
• Oriented to goal seeking	• Oriented to learning
• Assumes the world contains "systems" that can be engineered	• Assumes the world is problematical but can be explored using systems models of concepts of purposeful activity to define "action to improve"
• Assumes systems models to be models of (part of) the world (*ontologies*)	• Assumes systems models to be devices: intellectual constructs to help debate (*epistemologies*)
• Talks the language of "solutions"	• Talks the language of "issues" and "accommodations"
• Philosophically: positivistic	• Philosophically: phenomenological
• Sociologically: functionalist	• Sociologically: interpretivist
• Systemicity: lies in the world	• Systemicity: lies in the process of inquiry into the world

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Soft OR/PSMs/MS and Engineering Practice?

- Problem Structuring Methods emerged from:
  - Soft Systems Methodology (Checkland 1981) – the failure of Systems Engineering in complex organisational problems
  - Operations Research e.g. "Optimization + objectivity = opt out" (Ackoff 1977)
  - Attempts to 'soften' systems thinking approaches e.g. qualitative System Dynamics (Coyle 1998, 2000)
- independent strand(s) of thinking largely in the UK
- strong flavour of action research, learning systems, qualitative enquiry, ethnomethodology, process rather than variance methodology (de Ven & Poole 2005)

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What are Problem Structuring Methods (PSMs)?

- methods, not mathematical, but structured and rigorous and based on qualitative, diagrammatic modelling
- allow for a range of distinctive views to be expressed/explored/ accommodated and allow for multiple and conflicting objectives
- encourage active participation of stakeholders in the systems modelling process, through facilitated workshops and cognitive accessibility
- can facilitate negotiating a joint agenda and ownership of implications of action
- aim is for exploration, learning and commitment from stakeholders, rather than optimisation, prediction, solution…

Adapted from (Mingers, 2011; Mingers & Rosenhead, 2004; Rosenhead, 1996)

(Yearworth & White, 2014)

Generic properties of PSMs

1. taking action to improve
2. using a systemic approach
3. being creative and adapting existing methods
4. achieving methodological learning
5. taking into account different worldviews
6. acknowledging the wicked/messy problem situation
7. being interactive, iterative and therapeutic
8. acknowledging subjectivity
9. mitigating conceptual limitations in approach

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Problematizing engineering – topics

- failure, waste, scandal, risk, death…
- technological determinism
- liberal forms of self-regulation and the emergence of professions; the problem of desirable (best?) practice as *not*-malpractice
- obfuscated values, unacknowledged subjectivity, behavioural biases, assumption of privileged worldviews
- naïve empirical realist ontology, atheoretical pragmatism, instrumental rationality
- …

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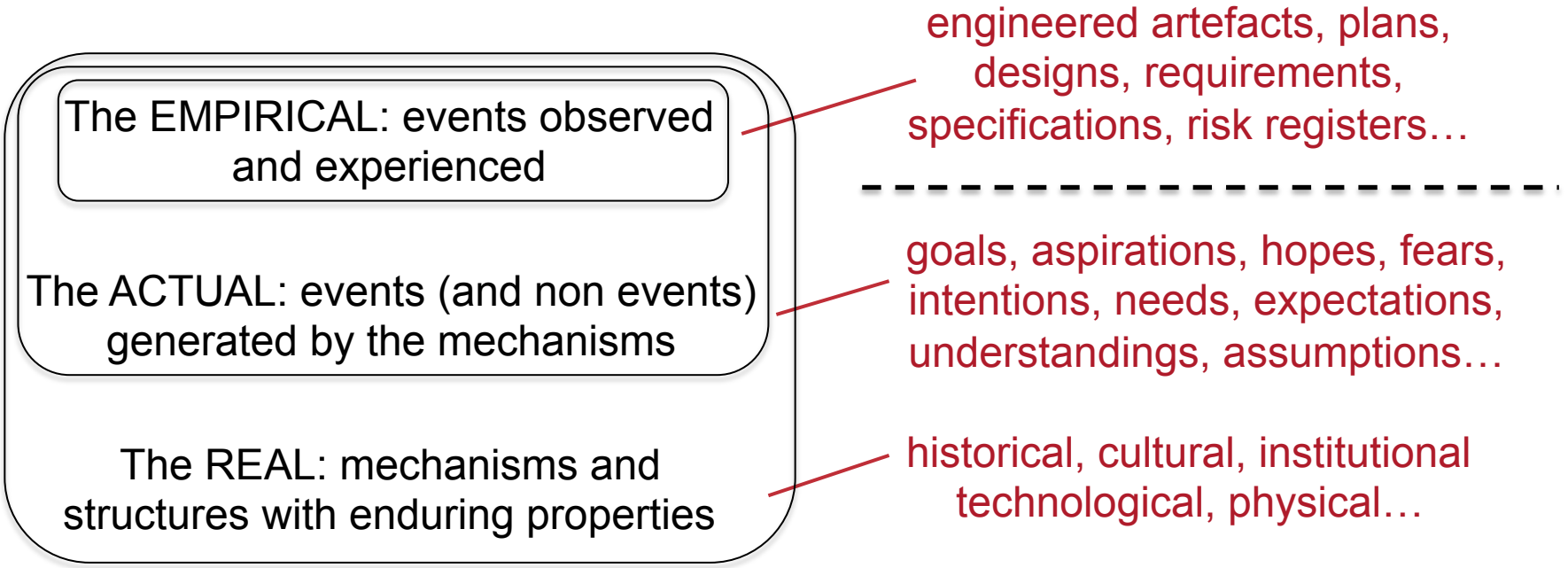
Possible research agendas from problematizing

1. transcending naïve positivism? A return to Comtean Positivism?
2. pragmatism revisited? Dewey, Peirce, Rorty…
3. Critical Realism
4. frameworks of Anticipation
5. SSK/STS view of the *process* of engineering, e.g. Pickering's Mangle of Practice/Performative Idiom leading to Soft Engineering
6. others …

(Bhaskar, 1975; Mingers, 2004)

Critical Realism

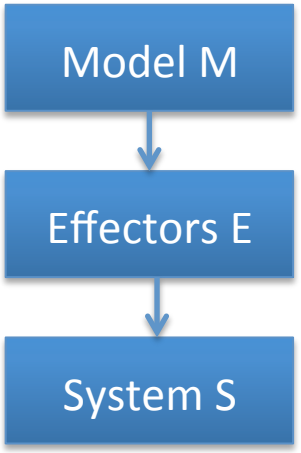
- Bhaskar's theories of transcendental realism and critical naturalism



(Rosen, 2011)

Anticipatory Systems

- systems containing internal predictive models of themselves and/or their environment
- what is a model? What is a predictive model? How do systems without predictive models differ from those that do?



- partition state space of M, S into desirable/undesirable
- so long as M desirable no E
- bad models, bad effectors ➔ side effects
- even if M, E perfect ➔ still surprises

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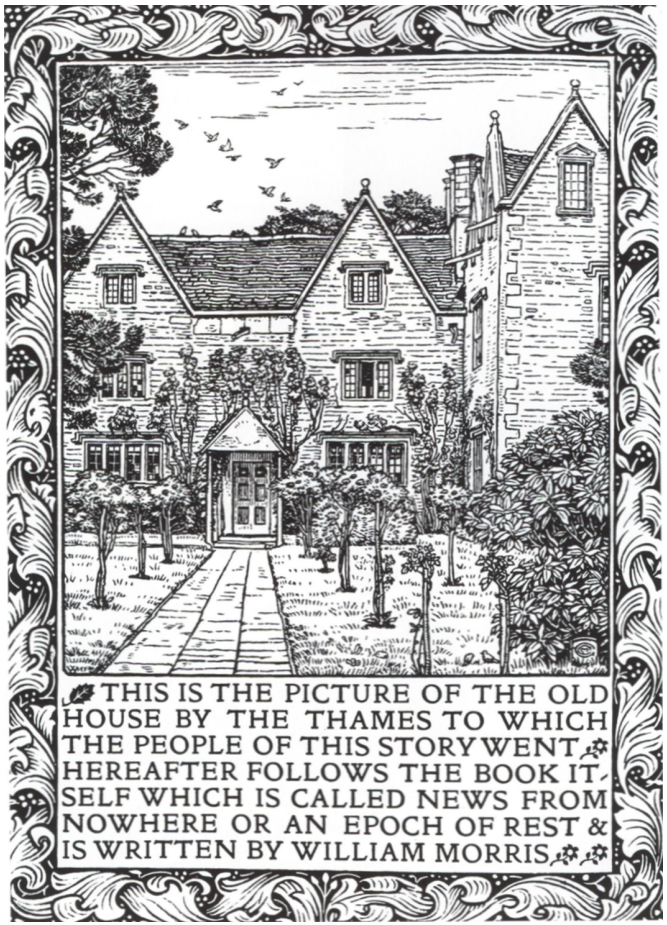
New futures studies and Anticipation - Poli

Forecast→Foresight→Anticipation

Anticipatory→Foresight→Forecast

Utopia as method - Levitas

- pre-figurative practices embedding better ways of relating together
  - convergence to coherent change at societal scales and democratic improvement
  - cf Miller: divergence, disruption, revolutionary
- utopias – always provisional and contested, reflexive, dialogic



(Adams, Murphy & Clarke 2009)

Dimensions of Anticipation

- Injunction
  - moral imperative to characterise and inhabit states of uncertainty; the actuarial world of risk
- Abduction
  - requisite 'tacking' between futures, pasts and presents; resonant with how engineering seems to operate
- Optimization
  - moral responsibility to secure the 'best possible futures'; especially engineering to constraints
- Preparedness
  - living in preparation for future trauma; risks materialise as events
- Possibility
  - 'ratcheting-up' of hopefulness through technoscience; e.g. more sophisticated defence mechanisms, resilient infrastructure, early warning systems…

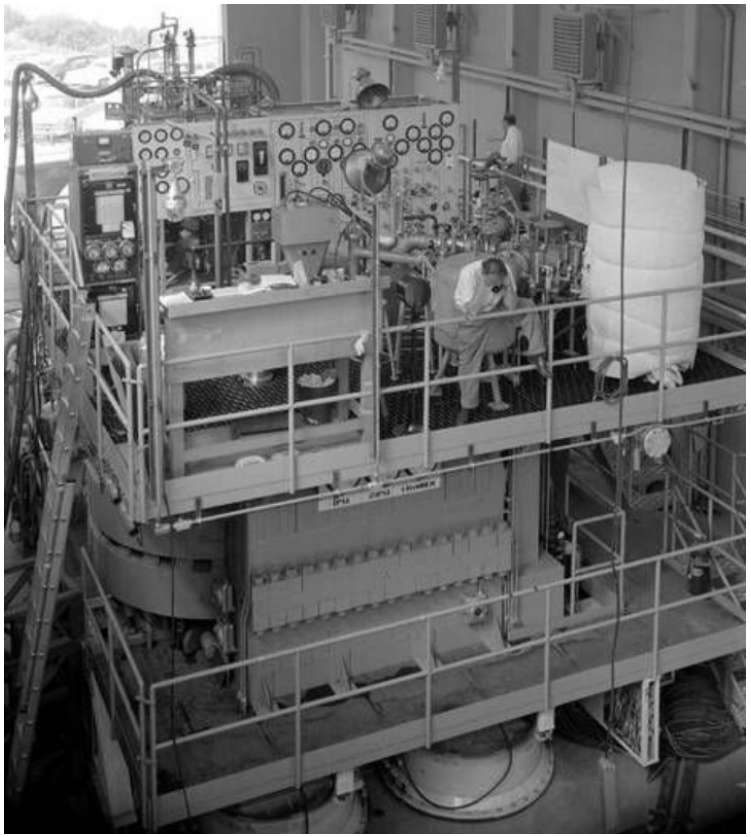
(Pickering 1993, 1995)

The Mangle of Practice / Performative Idiom

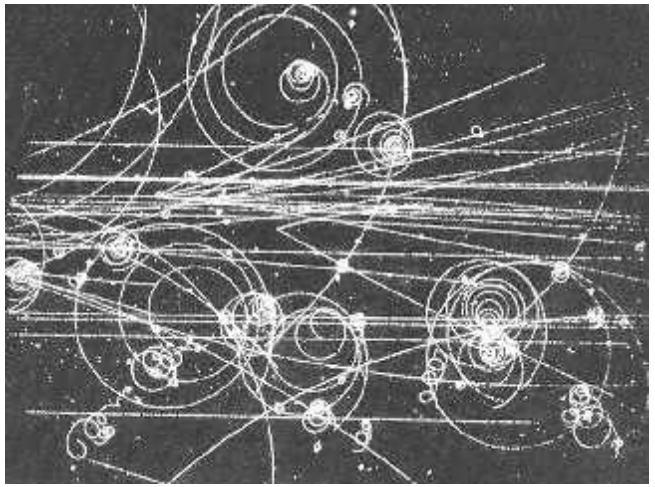
- Pickering's (1993, 1995) Mangle of Practice
- The "*performative idiom, capable of recognizing that the world is continually doing things and so are we*" (Pickering, 1995 p. 144)
- Such a view requires the concept of agency: who or what motivates and controls the forward momentum of action?
- Actor-network theory (ANT) expands the humanistic view of SSK with the claim that material, machinic things can also be taken to provide agency …Pickering goes a step further allowing agency to reside in concepts and methodologies as well
- Pickering's (1995) perspective focuses upon achieving a "*real-time understanding of practice*" by exploring how "*human and nonhuman agency…temporally intertwine*"

(Pickering 1993, 1995)

The Mangle of Practice / Performative Idiom



(Pickering, 1995, Ch 2)



Soft Engineering

- the realm of Engineering *know why*, rather than know how
  - engineering in the performative idiom
  - a refocusing of attention on the *process* of engineering rather than its content (the representational)
  - ethical engagement, starting with questioning purpose rather than simple justification via injunction
  - distinct move away from purely instrumental behaviour

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Characteristics of Soft Engineering

1. practising ethically and reflectively (not the same as *not*-malpractice)
2. widening participation and engagement; facilitating as well as being expert (knowledge co-production)
3. changing perspective away from singular outcomes and privileged viewpoints (optimum, best, right… solution…)
4. recognising multiple viewpoints, conflicts and power
5. embracing a broad systemicity in approach, especially in how models are used (double systemicity)
6. being aware of conceptual limitations, values, and subjectivity
7. engaging in a process of action research/learning
8. regarding performative knowledge equal with representational

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(Lane et al., 2011)

An encouraging example

Transactions of the Institute of British Geographers

Royal Geographical Society with IBG

Advancing geography and geographical learning

Doing flood risk science differently: an experiment in radical scientific method

S N Lane*, N Odoni*, C Landström**, S J Whatmore**, N Ward† and S Bradley‡

In this paper, we describe an experiment in which the position of scientists with respect to flood risk management is fundamentally changed. Building on a review of three very different approaches to engaging the public in science, we contrast the normal way in which science is used in flood risk management in England and Wales with an experiment in which knowledge regarding flooding was co-produced. This illustrates a way of working with experts, both certified (academic natural and social scientists) and non-certified (local people affected by flooding), for whom flooding is a matter of concern, and where the event, flooding, is given agency in the experiment. We reveal a deep

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Conclusions

- The Soft Engineering project is…
  - an attempt to change engineering behaviours, grounded in ethical practice encompassing procedural and distributive justice
  - acknowledges pragmatism as an essential element of engineering practice, but opposes the prevalent atheoretical stance
  - situated in appropriate theoretical foundation(s), but wary of grand narratives
  - an appeal for more studies of engineering practice, especially in developing critical/reflective perspectives

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Questions?

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