

SPRU – Science & Technology Policy Research



Opening Up Scientific Incertitude:

implications of uncertainty for science policy and expert evidence

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'Sound Science' in Policy and Regulation

on zoonotic pandemics:

"... sound science ... science-based decisions" - UN WHO DG Margaret Chan

on genetic modification:

"... this government's approach is to make decisions ... on the basis of **sound science**" - former UK Prime Minister, Tony Blair

on chemicals:

"...**sound science** will be the basis of the Commission's legislative proposal..."

- EC RTD Commissioner, Philippe Busquin

on energy:

"[n]ow is the right time for a cool-headed, evidence based assessment ... I want to sweep away **historic prejudice** and put in its place **evidence** and **science**"

former UK Energy Minister Malcolm Wicks









Justification: from political 'problems' to technical 'puzzles'







Conventional 'risk practices' suppress our 'knowledge about knowledge'

Conventional expert practices suppress our 'knowledge about knowledge'

marginalises, elides, ignores, (often) denies radical openness of 'incertitude':

- **insufficiency:** knowledge efficacy is not normative basis for action Aristotle, Kant, Habermas know-how is less important than know-why

- eg: how to apply **neuroscience?**



Conventional expert practices suppress our 'knowledge about knowledge'

marginalises, elides, ignores and (often) denies **realities** of knowledge:

- insufficiency:

knowledge efficacy is not normative basis for action

- incompleteness: knowledge enabling utility is limited on wider effects Lao Tzu, Socrates, Keynes 'unknowns' as important as 'knowns'

> – eg: unexpected mechanisms in **nanohealth** technologies



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marginalises, elides, ignores and (often) denies **realities** of knowledge:

- insufficiency: knowledge efficacy is not normative basis for action

- incompleteness: knowledge enabling utility is limited on wider effects

- indeterminacy: effective knowledge does not preclude surprise Gödel, Dosi, Collingridge "known knowns" foster hubris

eg: dangers of thinking we know
 halogenated hydrocarbons
 CFCs and the ozone hole
 endocrine disruptors
 methyl tertbutyl ether

Conventional expert practices suppress our 'knowledge about knowledge'

marginalises, elides, ignores and (often) denies realities of knowledge:

- insufficiency:
- incompleteness:
- indeterminacy:

- '**inversity':** *Einstein, Ravetz, Beck...* knowledge efficacy is not normative basis for action

knowledge is always limited as a basis for action

effective knowledge does not preclude surprise

increased knowledge can increase ignorance area / perimeter of known

nonlinear
 dynamics
 of climate
 and oceans



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- incompleteness: knowledge is always limited as a basis for action
- indeterminacy : effective knowledge does not preclude surprise
- 'inversity': increased knowledge can increase ignorance

- **intractability:** knowledge-commitments compound vulnerability *Ellul, Wynne, Tenner not existence but <u>exposure</u> to unknown*

eg: **nuclear** dependency



Conventional expert practices suppress our 'knowledge about knowledge'

marginalises, elides, ignores and (often) denies realities of knowledge:

- insufficiency: knowledge efficacy is not normative basis for action
- incompleteness: knowled
 - indeterminacy :
 - 'inversity':
 - intractability:

- incommensurability: Kuhn, Arrow, Jasanoff...

- knowledge is always limited as a basis for action
 - effective knowledge does not preclude surprise
 - increased knowledge can increase ignorance

knowledge-commitments compound vulnerability

knowledges are plural and often conflicting knowledge often not linear / additive

- eg: agronomy, ecology, soil science, molecular biology on **GM**



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intractability: knowledge-commitments compound vulnerability
incommensurability: knowledges are plural and often conflicting

representing incomplete knowledge as expert 'risk' is deeply problematic

Beyond Risk

contrasting aspects of 'incertitude'

unproblematic

knowledge about likelihoods

RISK

engineered components closed deterministic systems high frequency incidents familiar contexts

open dynamic systems low frequency events human factors changing contexts

problematic

UNCERTAINTY

- Socrates, Lao Tzu, Knight, Keynes, Shackle, Collingridge, Smithson, Ravetz, Wynne ...

Beyond Risk

contrasting aspects of 'incertitude'

knowledge about possibilities

unproblematic

problematic

unproblematic

knowledge about likelihoods

RISK

engineered components closed deterministic systems high frequency incidents familiar contexts

AMBIGUITY

defining pros & cons contrasting impacts diverse perspectives alternative options

open dynamic systems low frequency events human factors changing contexts novel agents or vectors surprising conditions new alternatives wilful blinkers

problematic

UNCERTAINTY

IGNORANCE

- Socrates, Lao Tzu, Knight, Keynes, Shackle, Collingridge, Smithson, Ravetz, Wynne ...

Pressures for Closure

institutional drivers of risk assessment



risk focus is shaped by power - Beck's "organised irresponsibility"

precaution and participation are about rigour

knowledge about possibilities

unproblematic problematic unproblematic **RISK** AMBIGUITY aggregated probabilities optimisation algorithms synthetic decision trees Delphi / Foresight knowledge predictive modelling about likelihoods IGNORANCE problematic UNCERTAINTY

precaution and participation are about rigour

knowledge about possibilities

unproblematic unproblematic

> aggregated probabilities optimisation algorithms synthetic decision trees

Delphi / Foresight

predictive modelling

knowledge about likelihoods

burden of evidence onus of persuasion uncertainty factors decision heuristics interval analysis sensitivity testing

problematic

UNCERTAINTY



problematic

AMBIGUITY

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RISK

aggregated probabilities optimisation algorithms synthetic decision trees Delphi / Foresight predictive modelling

scenarios / backcasting interactive modelling mapping / Q-methods participatory deliberation democratic procedures

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burden of evidence onus of persuasion uncertainty factors decision heuristics interval analysis sensitivity testing responsive civic research curiosity monitoring, evidentiary presumptions flexibility, reversibility diversity, resilience, agility, adaptability

problematic

UNCERTAINTY

IGNORANCE

'Opening Up' Incertitude

precaution and participation are about rigour

knowledge about possibilities



'opening up': options, issues, approaches, possibilities, perspectives

From narrow 'decision rules' to broad-based 'deliberative process'

extend scope

additive, cumulative, synergistic effects; life cycles, compliance real world effects: closed systems': MTBE PCBs, DES; '

From narrow 'decision rules' to broad-based 'deliberative process'

additive, cumulative, synergistic effects; life cycles, compliance

explicit incertitude explicitly engage with uncertainty, ambiguity and ignorance reduction to risk: CFCs, EDCs, GMOs,

extend scope

From narrow 'decision rules' to broad-based 'deliberative process'

humility on science	sensitivities & proxies: mobility, persistence, bioaccumulation
explicit incertitude	explicitly engage with uncertainty, ambiguity and ignorance
extend scope	additive, cumulative, synergistic effects; life cycles, compliance

omission of persistence in organochlorines, MTBE, CFCs

pro-active research	prioritise open monitoring & surveillance & targeted experiment neglected monitoring: TBT, BSE; asbestos, benzene, PCBs
humility on science	, sensitivities & proxies: mobility, persistence, bioaccumulation
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pro-active research	prioritise open monitoring & surveillance & targeted experiment
deliberate argument	levels of proof, burden of evidence, onus of persuasion Swann Committee on antimicrobials, 1967 later ignored

alternative options	pros, cons, justifications for range of options & substitutes ALARA, BAT, BPM – ionising radiation, fisheries, acid rain
deliberate argument	levels of proof, burden of evidence, onus of persuasion
pro-active research	prioritise open monitoring & surveillance & targeted experiment
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alternative options	pros, cons, justifications for range of options & substitutes				
transdisciplinarity	collect all relevant knowledge, beyond 'usual suspects' MTBE / engineers; BSE / vets (clinical / toxicology / epidem.)				

Precaution, Participation, Adaptive Learning (cf: EEA, 2001) From narrow 'decision rules' to broad-based 'deliberative process'

extend scope	additive, cumulative, synergistic effects; life cycles, compliance				
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transdisciplinarity	collect all relevant knowledge, beyond 'usual suspects'				
engage public	independence through pluralism and robustness on values benzene, DES, asbestos, acid rain, fisheries				

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extend scope additive, cumulative, synergistic effects; life cycles, compliance explicit incertitude explicitly engage with uncertainty, ambiguity and ignorance sensitivities & proxies: mobility, persistence, bioaccumulation humility on science pro-active research prioritise open monitoring & surveillance & targeted experiment deliberate argument levels of proof, burden of evidence, onus of persuasion pros, cons, justifications for range of options & substitutes alternative options transdisciplinarity collect all relevant knowledge, beyond 'usual suspects' independence through pluralism and robustness on values engage public 'plural conditional' (not unitary definitive) inputs to policy debate 'open up' politics 'GM' (trans / syn / MAB), 'low carbon' (nuclear / CCS / renews)

Precaution, Participation, Adaptive Learning (cf: EEA, 2001) From narrow 'decision rules' to broad-based 'deliberative process' extend scope additive, cumulative, synergistic effects; life cycles, compliance explicitly engage with uncertainty, ambiguity and ignorance explicit incertitude sensitivities & proxies: mobility, persistence, bioaccumulation humility on science pro-active research prioritise open monitoring & surveillance & targeted experiment levels of proof, burden of evidence, onus of persuasion deliberate argument alternative options pros, cons, justifications for range of options & substitutes transdisciplinarity collect all relevant knowledge, beyond 'usual suspects' independence through pluralism and robustness on values engage public 'open up' politics 'plural conditional' (not unitary definitive) inputs to policy debate

Risks of different agricultural strategies

under assumptions of selection of UK expert policy advisers

organic

environmental

intensive

GM + labelling

GM + monitoring

GM + voluntary controls

Risks of different agricultural strategies

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	1			
organic				
environmental				
intensive				
GM + labelling				
GM + monitoring				
GM + voluntary controls				



Risks of different agricultural strategies

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GOVERNMENT

organic environmental intensive GM + labelling GM + monitoring GM + voluntary controls



low



Risks of different agricultural strategies

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Risks of different agricultural strategies

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