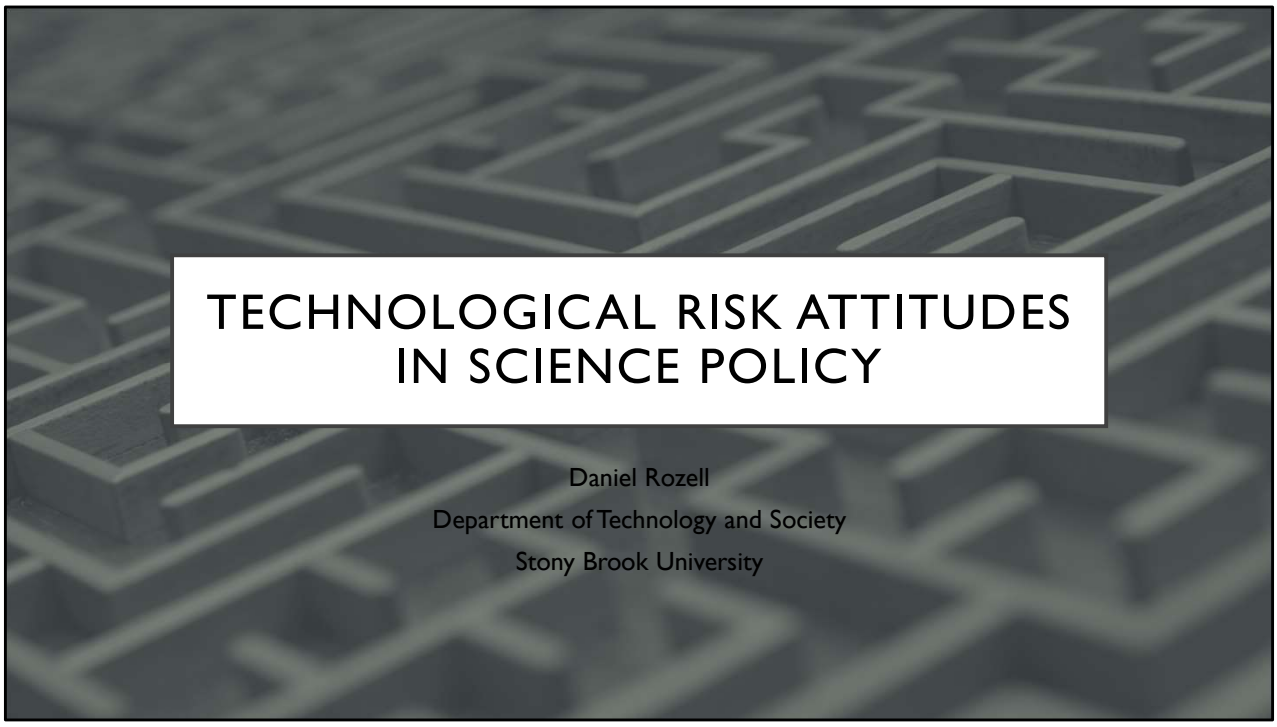

TECHNOLOGICAL RISK ATTITUDES IN SCIENCE POLICY

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Why are Technological Risk Attitudes Important?

Science policy decisions are often contentious

- Incomplete information due to new technology
- Lots of conflicting, but defensible data that opponents can use for support
- Inherent uncertainty of science and methods- what constitutes credible evidence is subject to its own debate

In the absence of convincing evidence and settled science, the public will often fall back on pre-existing technological risk attitudes

So where do these attitudes come from?

Science and technology studies pioneer Sheila Jasanoff criticizes the modern attitude that difficult technological decisions are always resolvable with further research – sometimes more data is no help at all – the issue is not technical, but values-driven

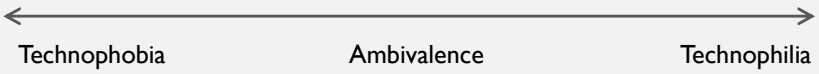
If we had adequate reliable information, then we might employ **rational choice theory** and maximize utility or **prospect theory** (Kahneman and Tversky 1979) and show aversion to large losses. But, what do we do in the face of incertitude? We tend to fall back on a heuristic model.

Heuristic (simple rule-of-thumb mental models) can be good for making common quick decisions but can be bad for unique complex problems – lead to stereotyping.

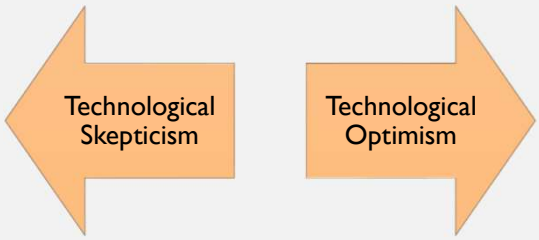
Risk attitudes can create a biased lens through which all technology and science is viewed

Categorizing Technological Risk Attitudes

Technological risk attitudes exist along a broad continuum



However, we can simplify for discussion - does attitude support or oppose a science policy?



Technological Optimists

Technological optimists believe in the liberating power of technology

- Modern medicine liberates us from disease
- Telecommunications and social media liberate our voice
- Space exploration liberates us from Earth

Although not confined in time or space, exemplified by American Modernist movement

Basis of support:

- Average life expectancy steadily increasing worldwide
- Extreme poverty rate steadily decreasing worldwide

Silicon Valley home to a lot of Tech. Optimists

Technological Skeptics

Technological optimists reject the technology-as-panacea paradigm.

Typical of the postmodern era critique of industrialization, but dates back to the Luddites

Basis of support:

- Environmental damage from modern living (pollution, biodiversity loss, climate change, etc.)
- Social disruption and economic instability

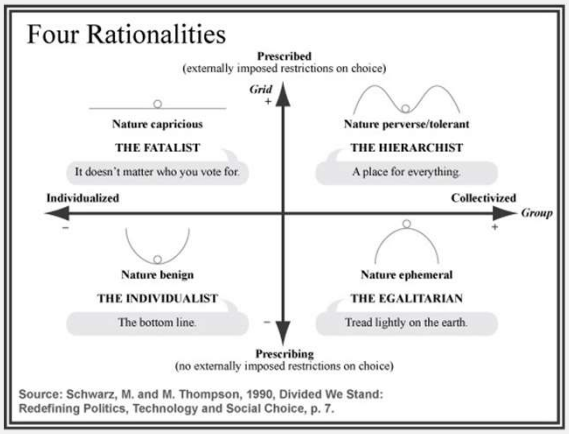
The Luddite rebellion, a brief spasm of violence between 1811 and 1813, was a reaction to the social upheaval caused as the steam engine and power loom rapidly shifted the wool industry in central England from family cottage weavers to coal-powered mills run by a few adults and cheap child labor. It is no coincidence Mary Shelley's Frankenstein, a seminal example of technological skepticism, was published in London in 1818.

Explaining the Differences

Using these definitions, how have technological risk attitudes been explained in the past? Here are some theories…

Cultural Theory of Risk

- Originated by anthropologist Mary Douglas and political scientist Aaron Wildavsky
- Four risk ideologies:
  - laissez-faire *individualists* (Technological Optimists)
  - social justice *egalitarians* (Technological Skeptics)
  - utilitarian *hierarchists* (follow the authorities/experts)
  - apathetic *fatalists* (opt out of policy-making)
- Despite its theoretical elegance, cultural theory has had limited predictive success

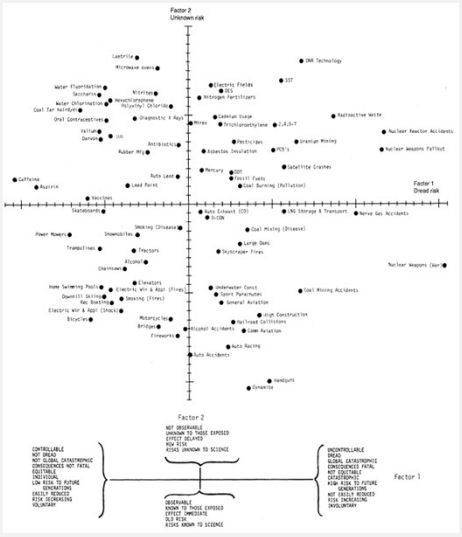


Individualists view human ingenuity as boundless and nature as robust.
Egalitarians view nature as fragile and have more precautionary views of technology

Cultural world view accounted for only 3% of the variance in surveys measuring the perception of risks and benefits of childhood vaccinations (Song 2014).

Psychometric Measures

- Risk-as-feeling model – Paul Slovic
- Useful for explaining why public risk perception often deviates from calculated risks
- Helps explore the many characteristics that affect perception of risk severity
- Despite its detail, psychometric methods are incomplete



Contrasts with Cultural Theory in that the emphasis is on the individual rather than social and political structures.

Figure from seminal 1987 risk perception paper by Paul Slovic published in *Science*.

A survey of perceived risk from the chemical industry in South Korea found less than 10 percent of the variance was explained by cultural theory or psychometric measures, which was less than even basic demographic factors, such as education level or gender (Choi 2013).

Cultural Cognition

- Cultural cognition theory is a hybrid of cultural theory and psychometric models – Dan Kahan and Paul Slovic
- Individuals preferentially select evidence that comports with the values of the cultural group with which they identify
  - evidence is more credible when experts appear to share their audience's values
  - information is more accepted if presented as consistent with existing cultural values
- However, the timing and interaction of influence between individuals and their social groups can be complex - cultural cognition theory has similar explanatory power to its parent theories

Lessons

Framing is important. For example, Pope Francis has called for Christian conservatives to be good stewards of a divine gift rather than talk about environmental protection in terms of regulatory intervention.

Likewise, scientists have found more success through direct local engagement with the public rather than lecturing them via social media. Someone from the community has more cultural credibility.

Other Theories Regarding Technological Risk Attitudes

Philosophers Jacques Ellul and Martin Heidegger - Attitudes derive from varying trust in the reliability of technology and our wisdom in using it

Sociologist Daniel Fox – Technological optimism related to fatigue with political process which gives rise to "technocratic solutionism" – the idea that conflicts about ideas, values and interests have technical solutions

Technocratic solutionism can misaddress a problem. For example – in the 20th century, famines have been due to hoarding and high prices brought about by bad governance and corruption (social problem) rather than inadequate food production (technical problem) - Amartya Sen

Some Unexplored Possibilities

Social psychologist Jonathan Haidt – Differences in ethical value systems between liberals and conservatives

- Moral thinking themes:
  - Prevention of harm
  - Fairness
  - Liberty
  - Loyalty
  - Authority
  - Sanctity

Liberals

Libertarians

Conservatives

Liberals
-Skeptical about technology with environmental impacts
-Optimistic about social media that encourages equality

Conservatives
-Skeptical of medical tech that offends sense of sanctity
-Optimistic about military technology that reinforces authority

Partially explains why technological attitudes do not clearly align with political ideology

The purity concept is central to the 'wisdom of repugnance' championed by bioethicist Leon Kass, the chairman of President Bush's President's Council on Bioethics

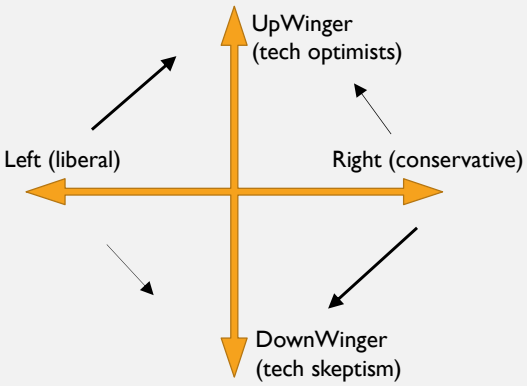
Some Unexplored Possibilities

Social epistemologist Steve Fuller – Re-ordering of political ideologies

- Shift from Left/Right (role of the state) distinction to Up/Down (role of technology)
- Borrows terms "Upwinger/Downwinger" from F.M. Esfandiary (aka FM2030)

<u>Risk implications</u>

- Upwingers are risk tolerant tech optimists
- Downwingers are risk-averse tech skeptics
- Proactionary vs. Precautionary



Left/right political labels come from the French National Assembly during the revolution (1789): Those who trusted tradition sat on the right, those who wanted to try new rationalist enlightenment ideas sat on the left. Today, the distinction is about the role of the state: the **left** believe the state can enhance civil society, while the **right** believes the state is merely a caretaker of social institutions

Upwingers believe in making humanity more than it is (transhumanism, space exploration, etc.)
Downwingers believe in humanity being solidly bound by evolution and earth (post-humanist environmentalists)

The new ideological dichotomy is not merely a rotation of the old groups but a reordering. Up-wingers would be expected to come from the technocratic left and the libertarian right, while down-wingers would encompass environmentalists from the left and religious conservatives from the right.

Downwinger figurehead – Communitarian traditionalist - Pope Francis
Upwinger figurehead – Technocratic libertarian - Elon Musk

Explaining Technological Risk Attitudes

In the end, none these individual theories is complete

However, they does give us a general idea of the range of factors at play

Also, multidimensional measures of risk perception do tend to have more explanatory power than single factor explanations

Let's turn to how technological risk attitudes change

For example, it is easy to imaging a person who is extremely supportive of medical research, cautiously optimistic about geoengineering as a temporary solution to climate change, but also slightly skeptical of GMOs, and highly skeptical about the value of social media. How would we classify that person's technological ideology?

Technological Risk Attitudes Change Over Time

Important question – If unchangeable, then risk assessments have limited value

Societal trends

- Modernism vs. Post-modernism
- Trace this evolution in attitude through science fiction

Individual experience with technology and its effects

- Medical devices and transhumanists
- Automation effects on socio-economic stability

Social trends:
Modernism – peaked with space age? Yet medicine and Silicon Valley have kept it alive

Romantic era of early science fiction, which encompassed the second half of the 19th century, envisioned the utopian potential of technology. For example, Jules Vernes' submarine Nautilus in *20,000 Leagues Under the Sea* is a technological marvel used to explore and catalogue nature, aid the oppressed, and oppose militarism

Subsequently, early 20th century saw a trend toward technological skepticism. Aldous Huxley's Brave New World (1932) is the epitome of the era. Like all literature, dystopian science fiction is a product of its time. The Cold War inspired nuclear annihilation inspired sci-fi, while more recent trends have focused on biotechnology.

Individual influences:
Positive experiences with transhumanism (Michael Chorost and Neil Harbisson)

Negative experiences with rapidly changing economic landscape. Travel agents, typists, toll booth attendants, telephone operators, video store clerks, and photo lab

employees are just a few of the many careers that quickly appeared, seemed as though they would always exist, and then just as suddenly disappeared.

Technological Risk Attitudes Vary by Geography

Great Britain was a center of early computer innovation

- Charles Babbage, Ada Lovelace, George Boole, Alan Turing, etc.
- So why is Silicon Valley in the U.S.?
- American technological optimism partially responsible

Geographical trends can shift with time and exhibit complexity

- Rise of American anti-scientism co-exists with a strong science research program
- Anti-vaxxers vs. NIH

Mark Bowles – pre-WWII, first practical differential analyzer (mechanical computer) was introduced in the US by Vannevar Bush and in GB by Douglas Hartree. (context: U.S. Engineering community vs. British scientific community). This practical machine was more readily and enthusiastically adopted by U.S. Engineers, while British scientists remained skeptical of the differential analyzer due to their theoretical professional style. As a result, Hartree was a "voice in the wilderness" in Britain, while Bush received extensive funding and had the support of an enthusiastic engineering environment

NIH is the world's largest funder of biomedical research and US has many major research universities and institutes

Technological Risk Attitudes Summary

Despite the lack of a comprehensive theory, it appears technological risk attitudes are influenced by a variety of factors that include culture, feelings, and personal circumstances. They also appear to be malleable over time at both the individual and societal level

Do these observations have any implications for how science and technology policy decisions are made? Can we make any general statements?

Principle of Dangerous Science

Observation 1: if something can be done that appears to have some intellectual or economic value, someone will view it as a valid idea and proceed before anyone else beats them to it

Observation 2: few lines of research or emerging technologies have been banned or abandoned in the past for reasons unrelated to science or practicality

An important result of opposing technical risk attitudes is that moral arguments against dangerous science are often downplayed and policymakers tend to act cautiously permissive

Principle: No line of research or technology will be banned on moral grounds

Obs. 1: basis of capitalism

Obs. 2: There have only been 3 research moratoria in the biological sciences
1- recombinant DNA research in 1974 (lifted within a year)
2- human reproductive cloning in 1997 – still unofficially in place
3 - influenza gain-of-function research in 2012 (lifted in 2017)

Human cloning never actually banned in the US despite legislative attempts in 1997, 2001, 2003, and 2005. Inspired by the birth of Dolly the sheep in 1996. However, once it was found defect rates were high in the cloned animals, commercial interest in cloning large animals diminished. Nevertheless, you can get your pet dog cloned in Korea for $100,000. In early 2018, the first successful cloning of primates was announced in China. This suggests the hurdles to human cloning are negligible. In the end, the US ban on human cloning did not stop research from walking right up to the forbidden line. If a new biotechnology has a use with tempting benefits, moral concerns provide a weak barrier.

Principle: we generally do not stop research just because it may be unwise, potentially harmful, or otherwise ethically dangerous. The result is dangerous science

generally moves forward until something eliminates the controversy. The controversy can be eliminated in one of several ways: new information or extensive experience reduces the perceived danger, cultural acceptance decreases opposition, or an alternative technology eliminates the need for the research.

In a 1954 hearing, J. Robert Oppenheimer, the lead physicist of the Manhattan Project, admitted an Achilles heel of scientists left to their own devices: ‘When you see something that is technically sweet, you go ahead and do it and you argue about what to do about it only after you have had your technical success. That is the way it was with the atomic bomb.’

Principle of Dangerous Science - Example

In 2015, Stanford synthetic biologists bioengineered yeast to convert sugar into morphine (biotech start-up created to generate commercially viable production levels)

Researchers said their work would help address existing pain-management crises in less industrialized countries

However, any international pain medication shortages are primarily caused by policy decisions rather than unaffordable medication. Research took place at the peak of an opioid addiction wave in the US., raising fears of homebrew heroin

Despite the obvious potential for misuse, the research was funded because opiates derived from yeast could reduce production costs

According to a 2017 Lancet report, the global need for morphine at retail costs only $145 million per year. Palliative care liquid morphine in Uganda cost about $2.50 for a week's supply

The general timing of announcements from competing research teams suggested the artificial urgency of a race for personal glory.

Benefits to areas, such as Afghanistan, where opium poppy production provides funding for military conflicts also served as further theoretical justification. Economic benefits aside, questions arise regarding the likelihood an improved process can be kept out of the illegal opioid market. Likewise, substituting poppy-derived opioids only impacts legal farming in India, Turkey, and Australia. The illegal opioid market fueled by Afghanistan would be unaffected unless the illegal market also converted to the new process.

Principle of Dangerous Science

Implications

Research will march on, don't worry too much about anti-science attitudes, science is too useful

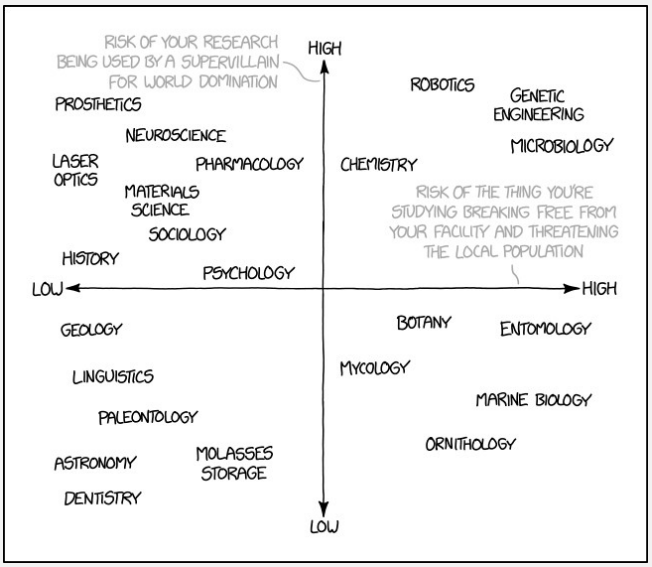
OK to push back a little harder in order to make sure it's done wisely

If technological skeptics want to be more effective in making their case for caution, they need to form pragmatic (not moral) arguments for their position and propose alternative solutions that address existing technological needs

Questions?

References and further reading can be found at:

Rozell, D. J. 2020. Dangerous Science: Science Policy and Risk Analysis for Scientists and Engineers. Pp. 57–76. London: Ubiquity Press. DOI: https://doi.org/10.5334/bci.d.



Research Risks
(https://xkcd.com/1904/)