Emerging Technologies: What Have We Learned About Governing the Risks?

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The Emerging Technologies Project

- Started with NRC committee; completed at ORNL
- Objective: identify ways to address *risks of emerging technologies*, drawing on
  - Experience with technologies now in place (nuclear power, radioactive waste management, DNA manipulation, etc.)
  - Early experience with currently emerging technologies (nano-, bio-, and info-)
  - Deduction from fundamental knowledge of social processes (risk perception and assessment; commons management, international institutions and networks; science communication and utilization)

Some Insights from the Nuclear Power Case

- Scientists tend to focus on distinguishing large vs. small risks; the public, on zero vs. non-zero risks
- Scientists tend to focus on the probability of a hazard; the public on the consequences
- Public concerns are strongly influenced by trust in risk management institutions
- Public concerns are related to whether or not the consequences are known from experience

Some Insights from Radioactive Waste Management

- Public perceptions matter in technology acceptance, regardless of whether technical experts think the judgments are wrong
- Public judgments are related to whether a possible consequence is dreaded, especially if the effects are potentially unbounded
- Population segments differ in risk judgments (white, male, affluent people see radioactive waste as less risky than other people do)
- Public participation can promote confidence in institutions and technologies

Some Insights from DNA Manipulation

- Risks should be analyzed and assessed not only as scientists view them but also as society is likely to view them
- It is easier to discuss risk issues before positions become hardened
- In many cases, risk assessment needs to be case-specific because consequences can depend on subtle differences in substance composition or use

Some Insights from Research on Risk Perception, Assessment, and Management

- Qualitative aspects of hazards are important (e.g., dread, controllability); there are multiple metrics of risk
- Different parties have different value priorities and even different understandings of a risk situation
- Usefulness of analytic-deliberative processes that include the "spectrum of interested and affected parties" (NRC, *Understanding Risk*, 1996)

Some additional, generic lessons

- Technology acceptance is fundamentally a social process
- Social impediments are more likely to arise if risk communication comes late
- Building trust through public participation can increase the likelihood of acceptance
- Boundary organizations that link producers and users of information about risk are important
- Information about benefits often developed more aggressively than about risks, leading to governance challenges later
- Non-governmental "policy networks" can perform important risk governance functions

Reference: P.C. Stern, T.J. Wilbanks, S. Cozzens, and E.A. Rosa, Generic lessons learned about societal responses to emerging technologies perceived as involving risks. ORNL/TM-2009/114. Oak Ridge National Laboratory, 2009.

Some Implications for Emerging Technologies

- Deliberation is especially important for problem formulation and if risks are not yet identified and cannot therefore be quantified, BUT…
  - In that situation, it may be hard to get meaningful input from the spectrum of interested and affected parties
- Established regulatory bodies may not be appropriately tasked because hazards are different or applications are global, SO…
  - Research on commons management may be relevant

Commons Governance/Management

- Elinor Ostrom, Nobel laureate in economics
- The problem: limiting damage to resource bases by private appropriation of depletable resources accessible to all
- What she studied:
  - local resource bases (e.g., forests, fisheries, water sources)
  - institutions created by resource users
- Conclusions: Eight "design principles" for managing commons

Identifying Governance Principles for Risks of Emerging Technologies

- Can the Ostrom governance principles be applied outside the domain of the kinds of commons she studied?
- Can they be extended to:
  - Global natural resources
  - Risks of technology
- New paper addresses these questions

Reference: P.C. Stern, Design principles for global commons: natural resources and emerging technologies. *International Journal of the Commons,* 2011, 5:213-232.

Characteristics of Local Resource Commons: Why the Theory Might not Generalize

- Geographic extent: tens to thousands of km2
- Number of appropriators: tens to thousands
- Commons are degraded intentionally
- Appropriators share an interest in preserving the commons
- Appropriators share common institutional and cultural context
- Resources regenerate on a human time scale, so learning is a feasible management strategy

How Global Resources are Different

Geog scale	Local Resouces	Global Resources
# of users	Thousands	Billions
Salience	Resouce use is conscious purpose	Resource use is a byproduct of intent
Dirstribution of interests, power	Benefits and costs internal among users	Significant externalities; interest and power differentials
Cultures, institutions	Homogeneous	Heterogeneous
Feasibility of learning	Good	Limited
Regeneration time	Less than a generation	More than a generation
Ease of understanding resource	Feasible without scientific training	Scientifically complex, limited predictive ability
Resource dynamics	Stable rules	Changing rules
Learning transfer across places	Possible	Difficult

Applicability of Ostrom's 8 Design Principles

- *Define boundaries for appropriators and resource:* Not applicable
- *Define rules congruent with ecological conditions:* Difficult to identify the conditions, enforce global rules
- *Allow most users to participate:* Size of group, need to understand science make this difficult
- *Hold monitors accountable:* Challenges include need for global monitoring, uncertainty about what to monitor, and diversity of those monitors should account to
- *Apply graduated sanctions:* Sanctioning authority is limited
- *Low-cost conflict resolution:* Disconnects between parties and generations makes difficult
- *External authorities permit local control:* Need to facilitate local control and learning; also limit externalization
- *Nested layers of organization:* same as above

How Emerging Technologies are Different from Resource Commons

- Some are integrated global systems, but some are global only in distribution
- Irreversible processes are endemic
- Scientific complexity, uncertainty, and ignorance are rife
- Strong conflicts of values between developers and affected parties
- Strong conflicts of interest, too
- Nature of the risks incompletely known (including an expectation of surprises)

Implications of the Differences

- Need for science is critical
- Need for anticipating risks (not only managing them) is also critical
- Strong interests imply need to insulate science from policy (Red Book model)
- Interests and value differences make that infeasible, calling for analytic deliberation

A Revised Set of Design Principles

1. *Invest in science* to understand resource/technology and its interactions with users and those affected
2. *Establish independent monitoring,* accountable to the interested and affected parties
3. *Ensure meaningful participation* of parties in framing questions, interpreting science, and developing rules
4. *Integrate scientific analysis and broadly based deliberation*
5. *Higher-level actors should facilitate participation of lower-level actors*
6. *Engage and connect a variety of institutional forms,* global to local, in making rules, monitoring, and sanctioning
7. *Plan for instituional adaptation and change* (iterative risk management)

Additional Principles Suggested by Global Commons Problems and Emerging Technologies

- *Invest in science*
- *Integrate scientific analysis with broadly based deliberation*
- *Plan for institutionalized adaptation and change (iterative risk management)*
- *Engage a variety of institutional forms* (not only levels of organization)

Source: Dietz, Ostrom, and Stern, The struggle to govern the commons, *Science,* 302:1907-1912.

Risk Governance Challenges and Synthetic Biology

- Identifying the risks before hazards are experienced
- Integrating the spectrum of interested and affected parties with cutting-edge science and unclear risks
- Coping with surprises (e.g., unexpected hazards)
- Developing rules and governance mechanisms that can adapt as risks become clearer
- Developing institutional forms that can meet the above challenges