SCIENCE and TECHNOLOGY POLICY:

GOVERNANCE APPROACHES

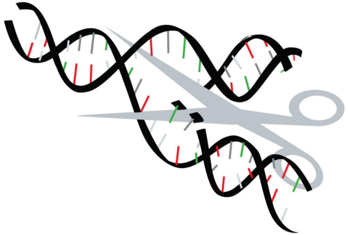
Shannon Danforth

First, some notes:

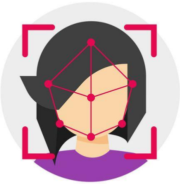
- This presentation's content is from PubPol 650
  - Introduction to Science and Technology Policy
  - Prof. Shobita Parthasarathy

- Also, certificate program for grad students at Michigan:
  - Science, Technology, and Public Policy (STPP)
  - Four policy-related classes
  - https://fordschool.umich.edu/stpp

Think about your own research...

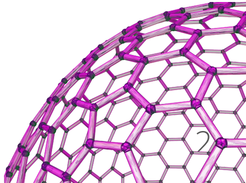


- Are there any current well-known controversies in your field?
    - Example: human gene editing



- Can your research dramatically change the way society operates?
    - Example: facial recognition in law enforcement

- Does your research aim to benefit a group that you don't work directly with?
    - Example: working on robotic prostheses in simulation
- Is your research difficult for the general public to understand or get excited about?
    - Example: nanotechnology



Example: Robots in the workforce

Robots Seem to Be Improving Productivity, Not Costing Jobs

by Mark Muro and Scott Andes

June 16, 2015

IDEAS MADE TO MATTER | ROBOTS

A new study measures the actual impact of robots on jobs. It's significant.

by Sara Brown | Jul 29, 2020

Robots and Workplace Safety

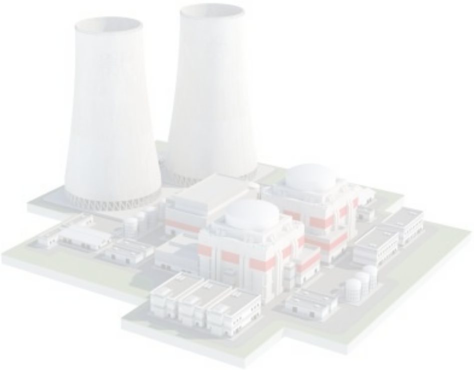
Robots and robot systems have become commonplace in many industries. From massive mechanical arms working on assembly lines to technologically advanced robots that interact with human coworkers, these machines bring unique safety concerns to the workplace.

How to develop policy/practices about robots in the workforce?

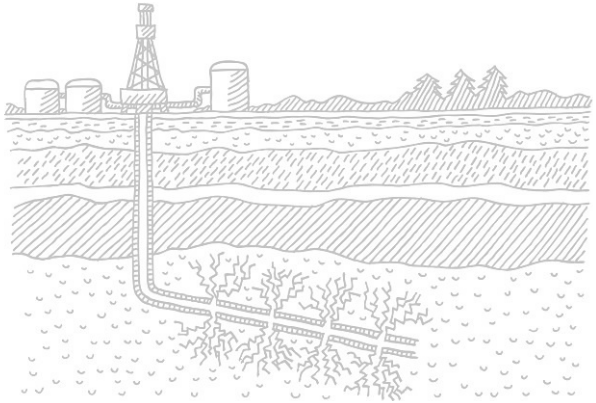
- **Stakeholders**: who does this new technology affect, and who can influence the outcome?
  - Employees who would work alongside robots
  - Employees whose job could get replaced by a robot
  - Higher-ups in the company concerned with budget
  - Consumers

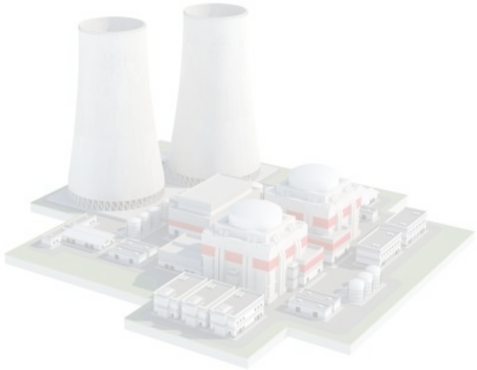
- **Values**: what do the stakeholders care about?
  - Safety in the workplace
  - Employment; economic challenges
  - Quality of product/service

- **Governance approach**: What should researchers and policymakers do next?



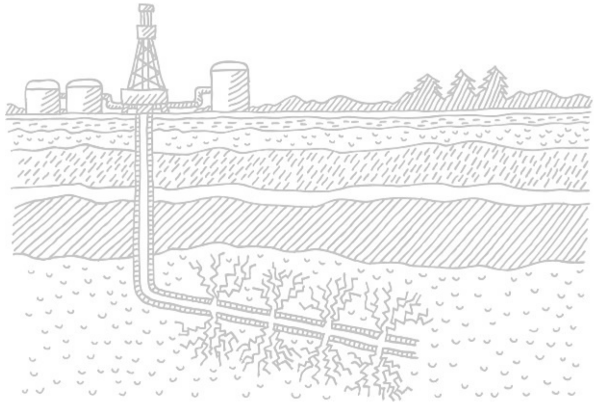
This presentation describes some strategies that policymakers use to make decisions about new **scientific developments**, emerging **technologies**, or science/technology **controversies**.





What are the advantages/disadvantages to each method?

Which ones would be easier for a grad student to implement?



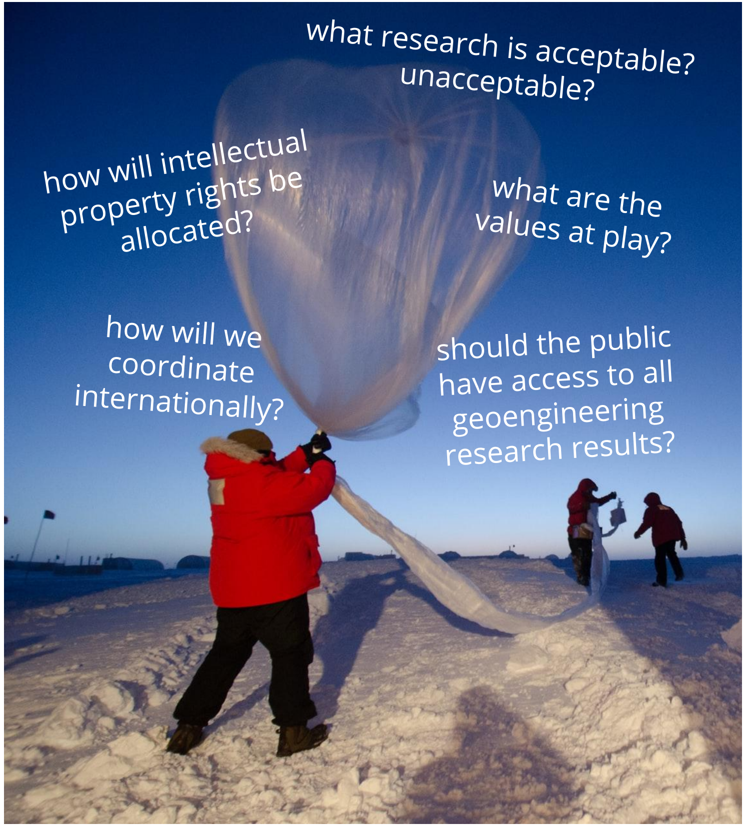
Government Advisory Committee

- A committee of (mostly) experts that provide recommendations for a STEM topic
- Some examples in bioethics in the US:
    - 1974 National Commission
        - Formed in aftermath of Tuskegee Syphilis Experiment, an ethically abusive study
        - IRBs, new ethical recommendations for research
    - 1994 Human Embryo Research Panel
        - Classify research areas as acceptable, unacceptable, needs review
        - Guidelines for responsible conduct of research
    - 2001 President's Council on Bioethics
        - Advise George W. Bush on a number of issues
- Varying levels of actual policy impact, plenty of criticism

Kelly, "Public Bioethics and Publics: Consensus, Boundaries, and Participation in Biomedical Science Policy," 2003

Government Advisory Committee

- Geoengineering: Reflecting sunlight back into space to reduce the effect of greenhouse gases
- Characteristics of committee
  - Independent *as a whole* - balanced perspectives
  - Transparent - publicly accessible proceedings
  - Deliberative - willing to provide several policy options
  - Publicly engaged - public hearings, educational materials, etc
  - Broadly framed - consider vulnerable populations, etc
- Who should be on the committee?
  - Experts from natural sciences, social sciences, humanities
  - Experience-based experts (environmental groups, business)
  - Representatives of potentially affected communities
  - Representatives of diverse political viewpoints



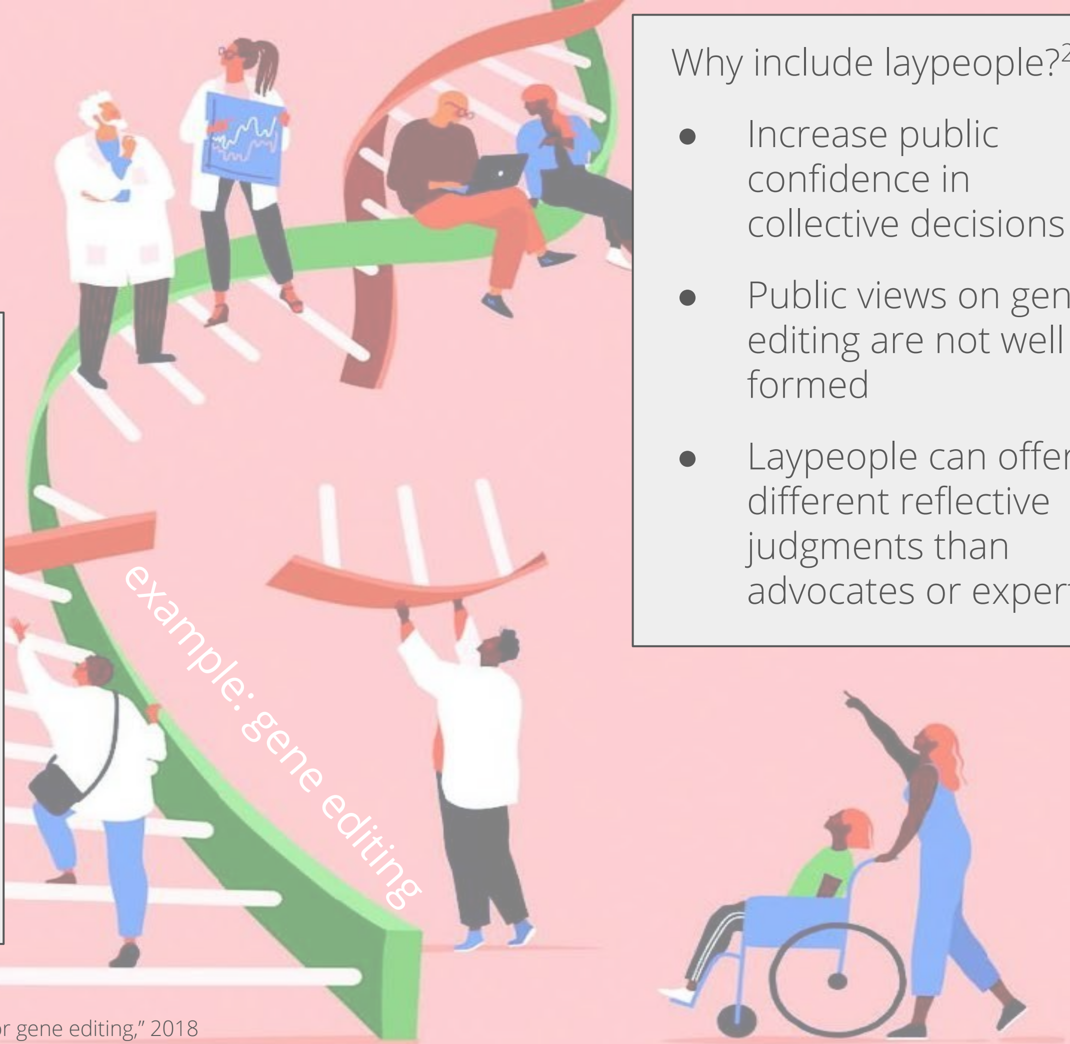
Winickoff and Brown, "Time for a Government Advisory Committee on Geoengineering Research," 2013

Global Observatory

An international network of scholars, organizations, and/or laypeople

Three goals:[1]

- Act as a clearing house to determine the global range of policy responses
- Track and analyze emerging areas of consensus and tension
- Convene meetings to discuss new developments



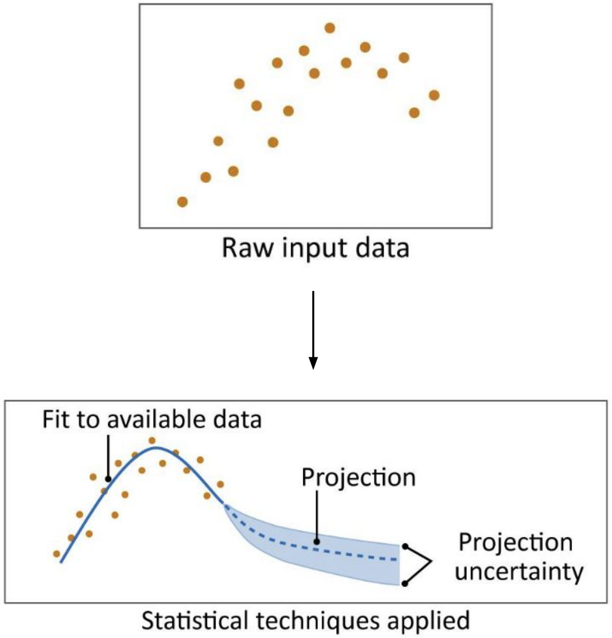
Why include laypeople?[2]

- Increase public confidence in collective decisions
- Public views on gene editing are not well formed
- Laypeople can offer different reflective judgments than advocates or experts

1. Jasanoff and Hurlbut, "A global observatory for gene editing," 2018
2. Dryzek et al., "Global citizen deliberation on genome editing," 2020

Science, Technology Assessment, and Analytics (STAA)

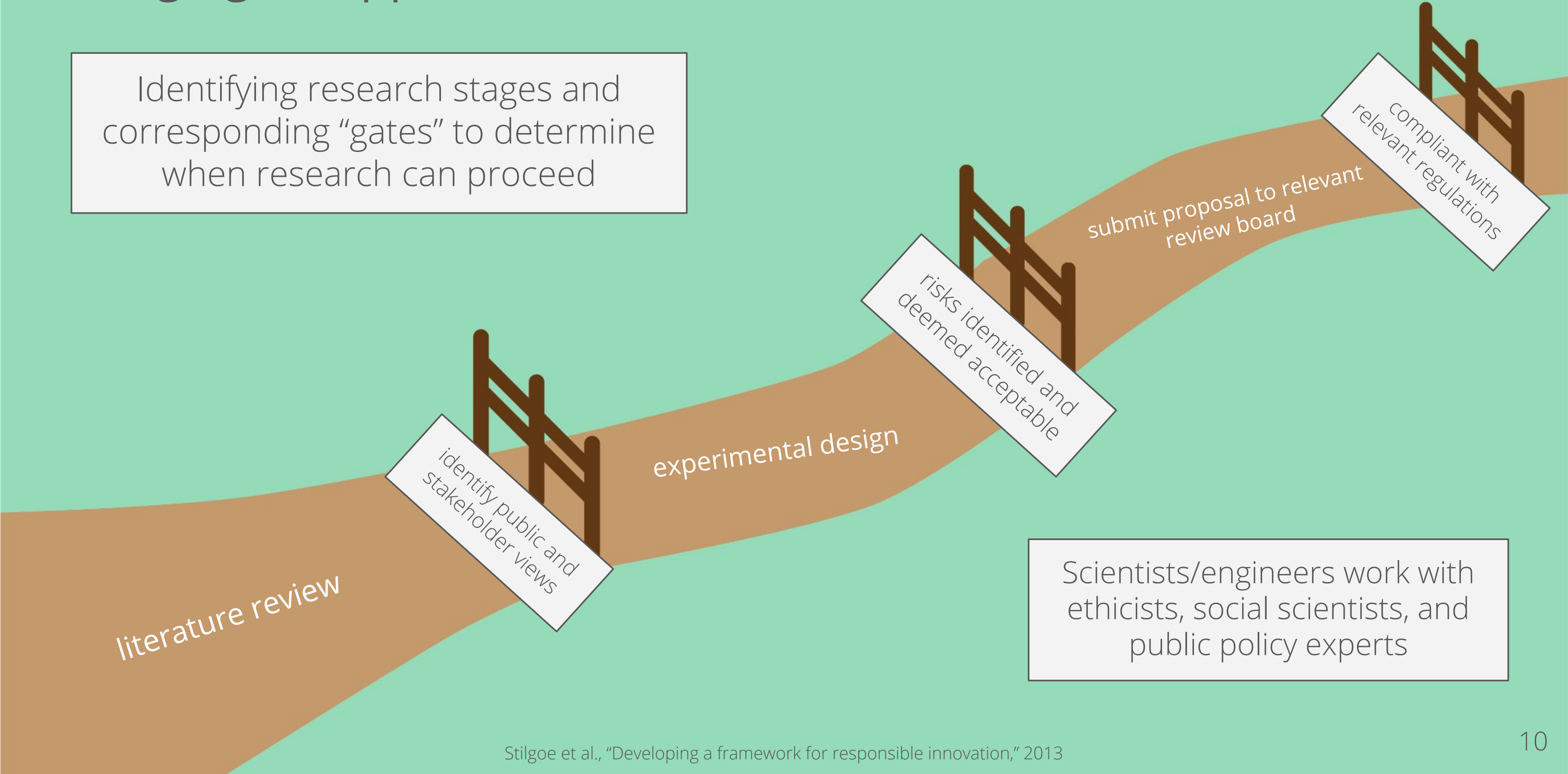
- A nonpartisan team within the Government Accountability Office
- Wide range of experts: technical, operations, public policy
- 94 current staff members
- Example: COVID-19
    - STAA team provided Congress with timely analysis
    - Reports on forecasting models, social distancing, vaccines
- Main goals:
    - Expertise - academia, think tanks, industry
    - Transparency - public and straightforward assessments
    - Trust - rigorous internal and external reviews



Persons, "The Return of Science and Technology Assessment for Congress," 2020

Stage-gate approach

Identifying research stages and corresponding "gates" to determine when research can proceed

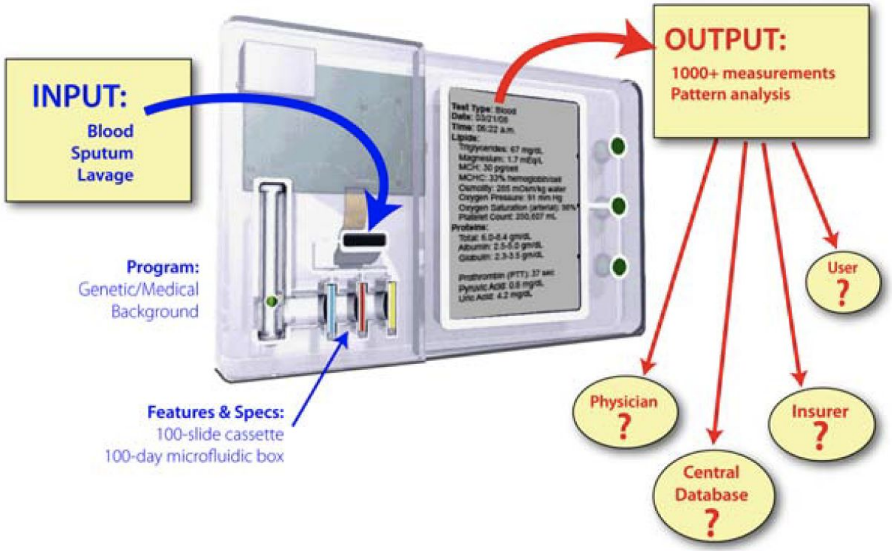


Scientists/engineers work with ethicists, social scientists, and public policy experts

Stilgoe et al., "Developing a framework for responsible innovation," 2013

Scenario planning

- Goal: how can we predict potential social/economic/political responses to a new technology?
- A group develops possible scenarios based on an emerging technology
- Example: Doc-in-the-Box from Arizona State University (2007)
- Workshop participants:
  - Healthcare analysts
  - Physicians
  - Policy analysts
  - Bioethicists
  - Political scientists
  - Sociologists
  - One user of a neural implant



Selin, "The Future of Medical Diagnostics: Scenario Development Workshop Report," 2007

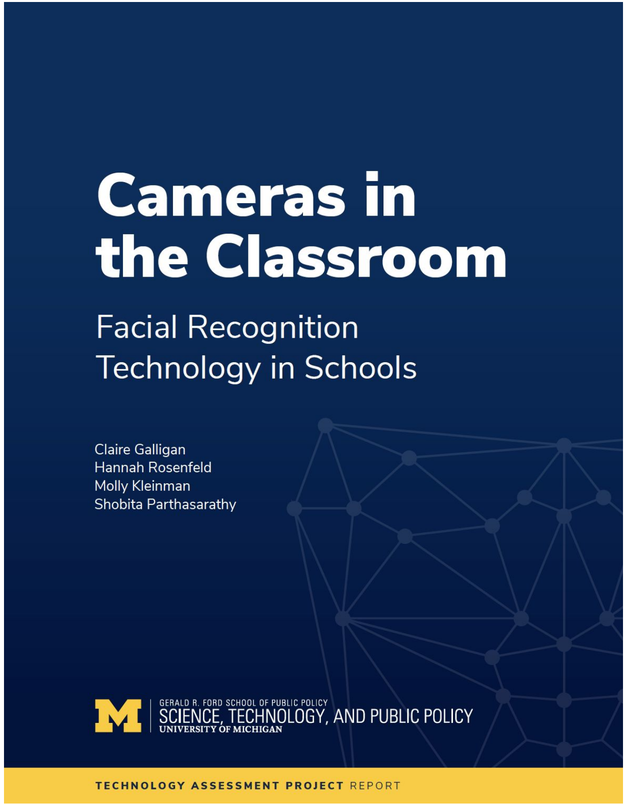
Scenario planning

		VALUE TO SOCIETY	
		Low	High
CONTROL	Individual	*Individuals who use Doc-in-the-Box are consumed by the daily read-outs, which causes anxiety. Further stress results from the lack of regulation and standardization of results, leading to inconclusive interpretations.*	*Society divides into Healthletes (users of Doc-in-the-Box, who live in Life Extension co-ops and buy supplements) and Natural Lifers, who do not consider health consequences of their lifestyle.*
	Institutional	*Congress passes legislation exempting Doc-in-the-Box from FDA oversight, then requires all diagnoses in the US to involve Doc-in-the-Box. Patients eventually lose their ability to make choices about their health.*	*Doc-in-the-Box helps eradicate a pandemic. It quickly identifies individuals who are immune to a virus and analyzes the proteins in their blood, then uses the information in vaccine development.*

Selin, "The Future of Medical Diagnostics: Scenario Development Workshop Report," 2007

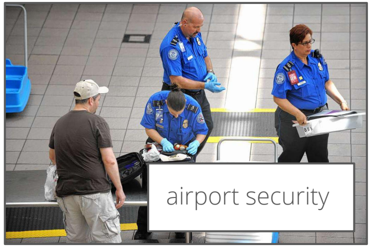
Analogical case study

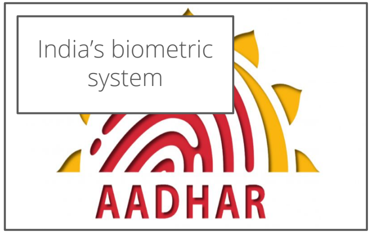
- Analyzing the development, implementation, and regulation of previous technologies
- Goal: Anticipate how a new technology might emerge and the challenges it will pose
- Recent example from a University of Michigan study
    - Facial recognition technology in schools
    - Outlines existing/anticipated issues
    - Describes the "policy landscape" for facial recognition
    - Policy recommendations at the local, state, and federal level

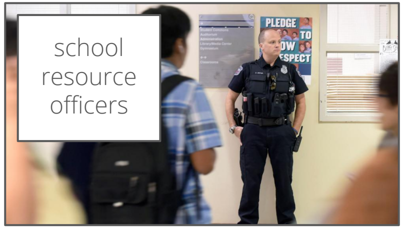


Galligan et al., "Cameras in the Classroom: Facial Recognition Technology in Schools," 2020

Analogical case study







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Facial recognition in schools is likely to…

- Exacerbate racism
- Normalize surveillance
- Narrow the definition of an acceptable student
- Commodify data
- Institutionalize inaccuracy

Galligan et al., "Cameras in the Classroom: Facial Recognition Technology in Schools," 2020

Participatory technology assessment (pTA)

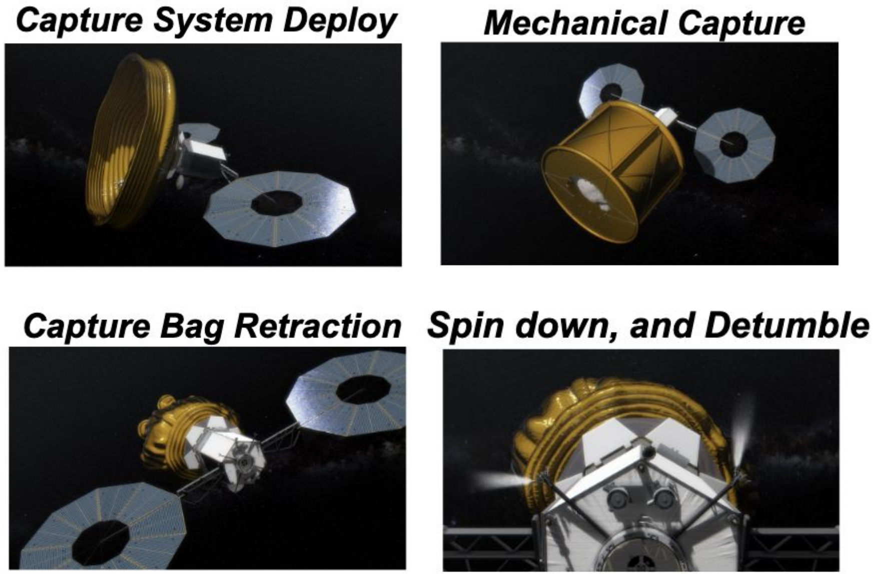
- A public deliberation method for:
  - Assessing the societal benefit of research
  - Empowering the public to consider science/tech decisions
- Example: NASA's Asteroid Redirect Mission
  - Deliberating two competing mission proposals
  - Two separate one-day forums (Boston and Phoenix), 80-90 participants each
  - Participants provided with read-ahead materials for each option
  - Small-group discussion
  - Q&A panel with anonymous experts
- Result:
  - Lay citizen rationales for choosing either option
  - Values present in each individual's decision

Tomblin et al., "Integrating Public Deliberation into Engineering Systems: Participatory Technology Assessment of NASA's Asteroid Redirect Mission" 2017

Participatory technology assessment (pTA)

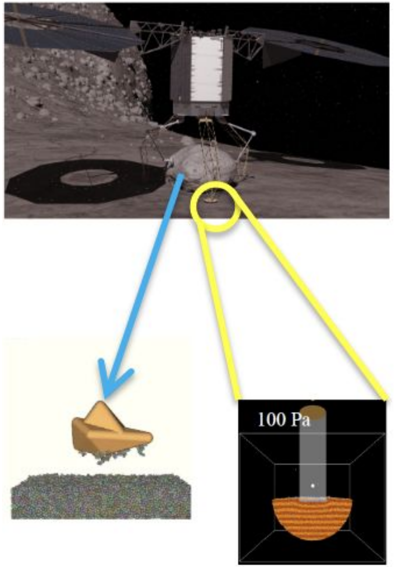
Option A:

Capture a small (10 m diameter) asteroid with inflatable bag.



Option B:

Retrieve a smaller (1-3 m diameter) boulder from the surface of a much larger (100 m diameter) asteroid using a robotic grabber.



Moore, "Asteroid Redirect Mission: Broad Agency Announcement," NASA, 2014

Tomblin et al., "Integrating Public Deliberation into Engineering Systems: Participatory Technology Assessment of NASA's Asteroid Redirect Mission" 2017

Participatory technology assessment (pTA)

Option A:

Capture a small (10 m diameter) asteroid with inflatable bag.

Benefits

- This technology could potentially be applied to the problem of clearing away space junk from low Earth orbit.
- A larger asteroid would yield more samples and eventually be more valuable.

Considerations

- Is the risk that the target turns out to be a rubble pile rather than a monolithic object acceptable?
- This option will require de-spinning the object before capture—an important capability to demonstrate for deep-space operations. Is this a compelling engineering challenge?
- Does the smaller choice of targets make this option less interesting?

Option B:

Retrieve a smaller (1-3 m diameter) boulder from the surface of a much larger (100 m diameter) asteroid using a robotic grabber.

Benefits

- The larger parent asteroid could be compositionally characterized before target selection, allowing a greater control over the properties of the retrieved object.
- Operations on the surface of the larger object are likely to be relevant to future human exploration than capturing a smaller object.

Considerations

- This option will allow a gravity tractor demonstration on a much larger object than option A, which could help advance planetary defense against an asteroid threatening the Earth. Is this a compelling engineering challenge?
- Is this option “cool” enough?
- Will the ability to select from many different boulders lower risk and improve the mission?

Tomblin et al., “Integrating Public Deliberation into Engineering Systems: Participatory Technology Assessment of NASA’s Asteroid Redirect Mission” 2017

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Table 2. Distribution of Concepts and Rationales between Options A and B.

Rationale	Option A	Option B	Combined (*n* = 183 statements)
Science	9	62	71 (38.8%)
Technology	7	32	41* (22.4%)
Sample	13	24	38* (20.8%)
Potential	6	28	34 (18.5%)
Success	8	25	33 (18.0%)
Control	7	24	31 (16.9%)
Mars	1	28	30* (16.4%)
Failure	4	3	7 (3.8%)
Gravity Tractor	0	29	29 (15.9%)
Exploration	1	24	28* (15.3%)
Planetary Defense	0	23	23 (12.6%)
Flexible	2	20	22 (12.0%)
Future	5	17	22 (12.0%)
Composition	7	13	22* (12.0%)
Landing	0	19	20* (10.9%)
Exciting	8	12	20 (10.9%)
Economic	7	11	18 (9.8%)
Proving Ground	2	12	17* (9.3%)
Data	1	14	15 (8.2%)
Help	0	12	13* (7.1%)
Space Junk	11	1	12 (6.6%)
Benefit	4	8	12 (6.6%)
Safety	3	8	11 (6.0%)
Mining	2	7	10* (5.5%)
Advance	1	8	9 (4.9%)
Practice	1	8	9 (4.9%)
Human	1	8	9 (4.9%)
Proven Technology	0	7	7 (3.8%)
Engineering	2	4	7* (3.8%)
Time	2	4	6 (3.3%)
Private	3	1	6* (3.3%)
Relevance	0	6	6 (3.3%)
Uncertain	0	4	5* (2.7%)
Ion	1	4	5 (2.7%)

Tomblin et al., “Integrating Public Deliberation into Engineering Systems: Participatory Technology Assessment of NASA’s Asteroid Redirect Mission” 2017

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Table 5. Combined Group and Individual Written Justifications for Table 4.

Table/ Participant	Option A	Most Important Factors/Primary Motivation
4	1	Scenario A. More material, space junk, side benefits.
4–1	1	Seems more probable.
4–2	1	It can pick up space junk as well as asteroids. It can get bigger asteroids, too.
4–3		Cost and safety.
4–4	1	Get a whole asteroid rather than a small piece of one. Practical application of also collecting space trash in orbit around Earth.
4–5	1	Larger sample for more research.
4–6	1	Scenario A allows us to take a larger sample of the asteroids. A single boulder may not be indicative of the materials and properties of its host asteroid. An entire one lets us have a larger sample until we have a focused research goal.
4–7	1	Smaller boulder in option 2 can be from another boulder and not necessarily able to give us the information for the "big 1." Also, love the idea of "cleaning" up the solar system.

Tomblin et al., "Integrating Public Deliberation into Engineering Systems: Participatory Technology Assessment of NASA's Asteroid Redirect Mission" 2017

Participatory technology assessment (pTA)

Option A:

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Option B:

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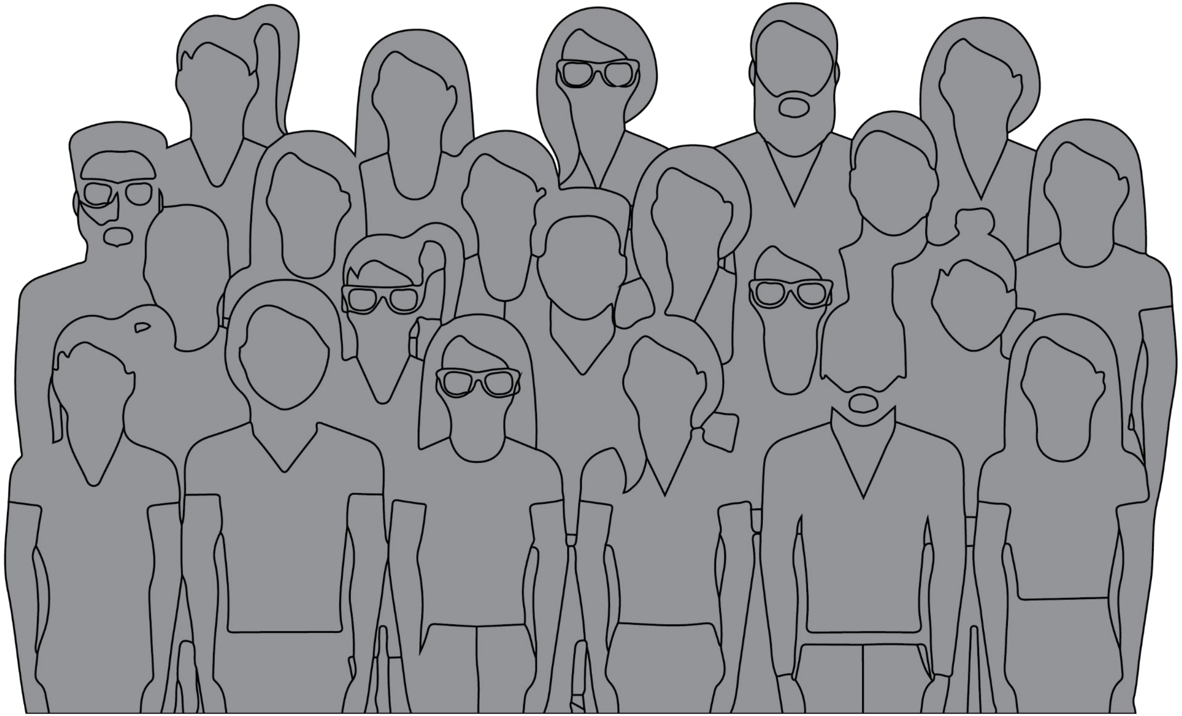
- The majority of pTA participants chose Option B
- NASA ended up choosing Option B as well
- Unclear how much pTA results influenced decision

Tomblin et al., “Integrating Public Deliberation into Engineering Systems: Participatory Technology Assessment of NASA’s Asteroid Redirect Mission” 2017

“Publics in particular”

Instead of viewing “the public” as one group with the same values…



“Publics in particular”

…we can consider how “publics in particular” can shape the socio-technical landscape

"Publics in particular"

- Example: Solar micro-grid in rural India
- In 2014, Greenpeace India established a solar micro-grid in a rural village (Dharnai)
    - Most residents previously did not have access to electricity
    - Greenpeace viewed decentralized solar grid as effective, community-led, sustainable energy
    - Falsely assumed the entire village had the same values
- In reality, two different interpretations spread among various social groups:

Non-User Group
● Already working towards getting the village connected to central grid ● Viewed solar micro-grid as incapable of addressing their energy poverty ● Generally viewed themselves as citizens: requested higher investment from the state

Sharma, " 'We Do not Want Fake Energy': The Social Shaping of a Solar Micro-grid in Rural India," 2020

“Publics in particular”

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Non-User Group	User Group
● Already working towards getting the village connected to central grid ● Viewed solar micro-grid as incapable of addressing their energy poverty ● Generally viewed themselves as citizens: requested higher investment from the state	● Already had private solar panels, so the micro-grid augmented their energy supply ● For some, “a matter of prestige” ● Others simply had no other choice for electricity ● Generally viewed themselves as consumers: actively deciding to purchase solar energy

Sharma, “ ‘We Do not Want Fake Energy’: The Social Shaping of a Solar Micro-grid in Rural India,” 2020

Consensus conference

- A method for eliciting community perspectives
- Organizers select a diverse group of 12-15 lay citizens
- The participants read background material
- Three formal meetings
  - Day 1: Discuss questions from the background reading
  - Day 2: Participants ask questions to a panel of experts
  - Day 3: Participants draft a report on their findings and recommendations
- Generally, participants hold a press conference after

Kleinman et al., “A Toolkit for Democratizing Science and Technology Policy: The Practical Mechanics of Organizing a Consensus Conference,” 2007

Consensus conference

Example: Nanotechnology (University of Wisconsin)

Criteria for success:

- Diversity of participants
- Quality of deliberative process
- Citizen participants' empowerment
- Impacts on policy and public debate

Challenges:

- Relatively low budget
- Low levels of public awareness about nanotechnology
- University location may have been intimidating
- Logistics: food, child care, transportation
- Did not budget enough time

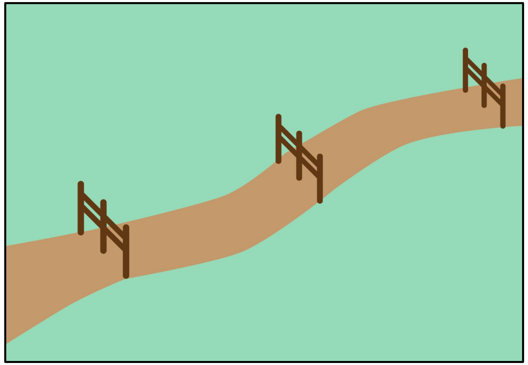
Successes:

- Participants satisfied with their final recommendations
- Lots of local/state press
- Participants said press conference was "powerful experience"
- General public education about nanotechnology

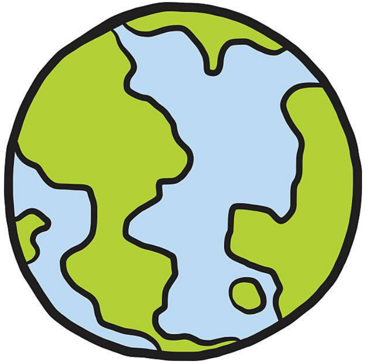
Kleinman et al., "A Toolkit for Democratizing Science and Technology Policy: The Practical Mechanics of Organizing a Consensus Conference," 2007

Applying these methods to robots in the workforce

stage-gate approach



global observatory



consensus conference

- How to conduct research while being mindful of conflict points?
- How to incorporate advice from experts while still listening to laypeople?
- How to ensure that any of these approaches would actually influence policy?