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SAND2020-9111C

Innovation Adoption, Technology Acceptance and Data Science: Why Algorithmic Technologies are So Tricky

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DoD Human Systems Integration CoP Seminar Series
14 September 2020

Sandia National Laboratories

U.S. DEPARTMENT OF ENERGY | NNSA

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RECOMMENDATIONS

Within our Community

- Establish a cross-disciplinary community of interest around innovation diffusion, adoption, acceptance and integration

With stakeholders, customers, and the other national security organizations

- Establish a cross-disciplinary COI around diffusion, acceptance, adoption dynamics in national security enterprises

With researchers evaluate and extend existing models

- Not clear that the literature on diffusion, adoption, acceptance, usage addresses the contextual particulars of large federal bureaucracies
- Consider multi-year project to develop and validate a protocol for assessing factors that make a workplace or analytic cell a viable ecological niche for an emerging algorithmic technology

TODAY'S DISCUSSION

ALGORITHMIC TECHNOLOGIES, ADOPTION, & ACCEPTANCE

- Most 'folk' models of innovation diffusion and adoption are incomplete.
- There's a large, well-established literature on innovation diffusion and technology acceptance/adoption.
- Does this literature speak to emerging algorithmic technologies – including data science, information visualization, visual analytics – and their prospects for integration into existing workflows?
- If the answer is, "Sort of, but…," what can we as practitioners be doing to address this gap?

An algorithmic technology is any technology that uses computational hardware, software, and code to implement and execute a process, logic, routine, or ‘recipe’ for acting on data.

TODAY'S THEMES

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COMMON NARRATIVES OF TECHNOLOGICAL CHANGE

THE 'FIELD OF DREAMS' MODEL

From https://www.imdb.com/title/tt0097351/mediaviewer/rm3374747392

THE ‘SELF-EVIDENTLY BETTER’ SCENARIO

https://time.com/3517011/thomas-edison/

THE 'OVER THE FENCE' APPROACH TO TRANSITION

Frame from Daily Telegraph, 'FedEx Worker caught throwing delivery over fence," 20 December 2011
https://www.telegraph.co.uk/news/worldnews/northamerica/usa/8968241/FedEx-worker-caught-throwing-delivery-over-fence.html

WHAT DO THESE HAVE IN COMMON?

If an innovation is "better," it will be useful.

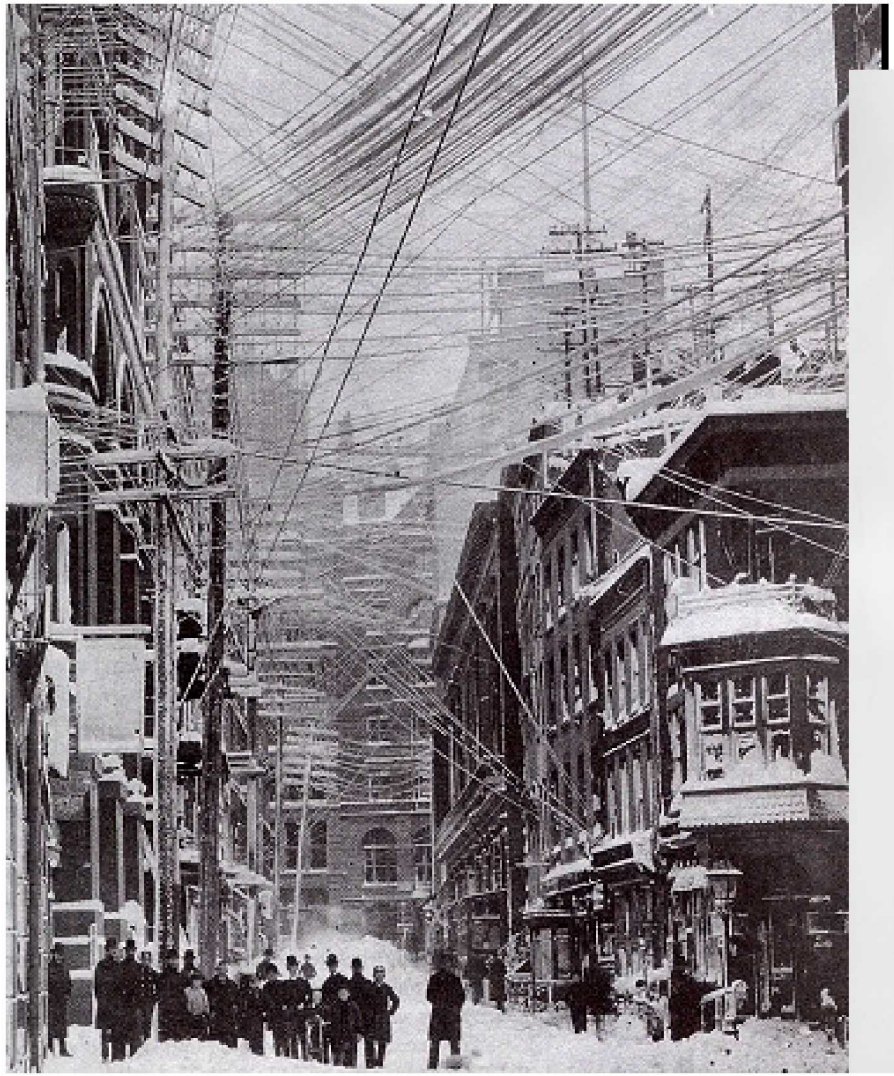
People want innovation, because they always want what's "better."

The value proposition of the innovation transcends context.

Innovations create their own momentum toward use.

Context will organize itself around the innovation.

EDISON DIDN'T (JUST) INVENT THE LIGHT BULB



"Building the invisible city". Virtual New York. 31 August 2020.

https://commons.wikimedia.org/wiki/File:Edison_machine_works_goerck_street_new_york_1881.png

HOW DOES TECHNOLOGICAL CHANGE HAPPEN?

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THE LITERATURE

Technology Acceptance

Diffusion of Innovations

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OFFICE TECHNOLOGY, MID-1970s

Image from https://www.bisley.com/news-insight/articles/the-office-through-the-decades-1970s/

https://commons.wikimedia.org/wiki/File:IBM_Selectric.jpg

https://commons.wikimedia.org/wiki/File:Ibm_pc_5150.jpg

“How do we get office workers to use computers?”

https://en.wikipedia.org/wiki/Tribble

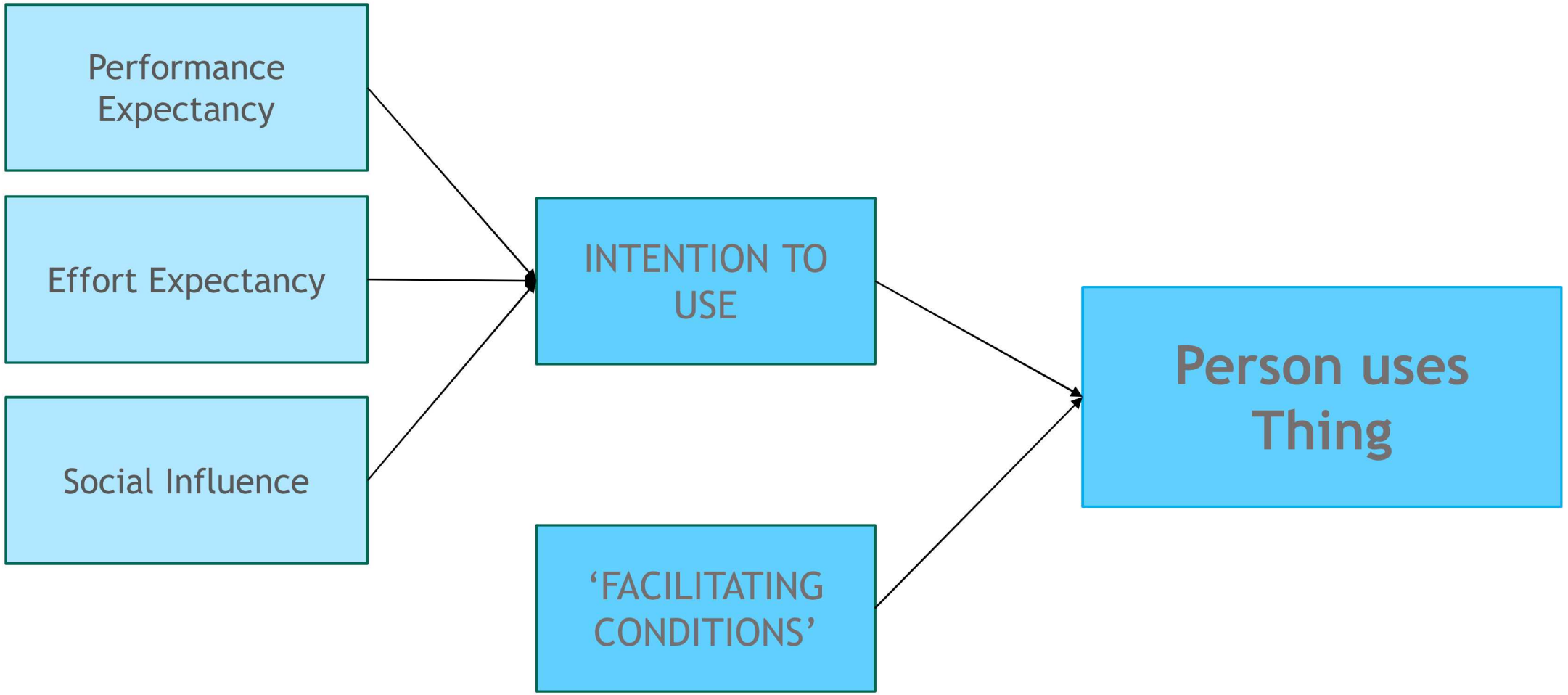
KEY PAPERS IN THE TECHNOLOGY ACCEPTANCE LITERATURE

1. 1983: Davis' Technology Acceptance Model (TAM)
2. 1988: Thompson's Model of PC Utilization (MPCU)
3. 1988: Leonard-Barton and Deschamps, Managerial Influence
4. 1989: Davis TAM 2
5. 1992: DeLeon and McLean's Information Systems Success Model (IS)
6. 1995: Goodhue and Thompson, Task-Technology Fit
7. 2002: DeLeon and McLean's Information Systems Success Model (IS)
8. 2003: Venkatesh et al's Unified Theory of Acceptance and Use of Technology (UTAUT)

UNIFYING THEMES

- Usage is (largely) equated with acceptance
  - Models tend to be concerned with the *intention* to use a new technology as a predictive factor in the *behavior* of use
- Heavily informed by social and behavioral psychology
  - Theory of Reasoned Action
  - Motivation Theory
  - Behavioral Control
- How is the technology/innovation perceived?
  - Will it be useful? (Relative advantage, value)
  - How difficult/easy will it be for me to use this? (Usability)

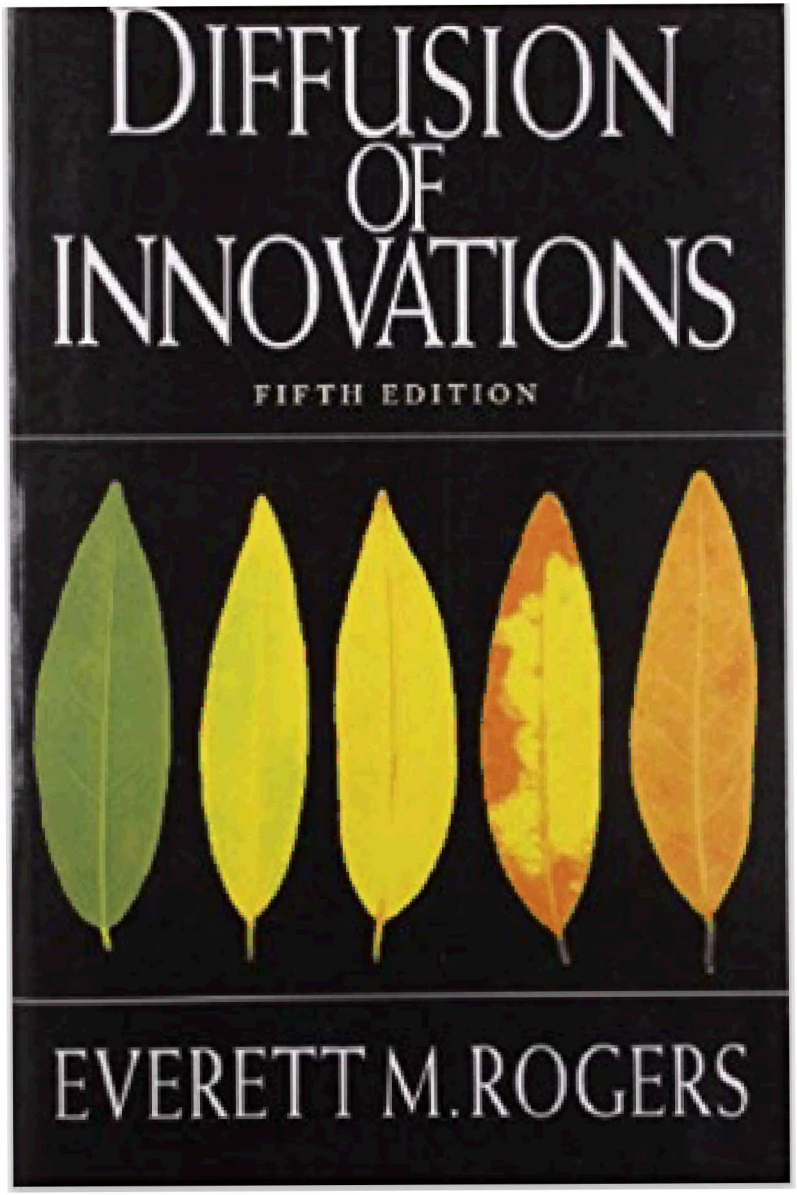
VENTAKESH ET AL'S UNIFIED THEORY, 2003



The Literature

Diffusion of Innovations

Technology Acceptance



- Diffusion Theory (SNA, Anthropology, Communications)
- Categories and Characteristics of Adopters
- Characteristics of Technologies
- The Decision Process
- Communication Networks

CHARACTERISTICS OF INNOVATIONS

1. **VISIBILITY**. How visible is this technology? How impactful is it? To what extent are its benefits describable to others?
2. **COMPATIBILITY**. How well does the technology fit into existing ways of doing work? Does the technology support the tasks and outcomes that people are responsible for achieving?
3. **TESTABILITY.** Can people experiment with, try out, get to know the technology, without making a wholesale commitment?
4. **COMPLEXITY.** How difficult is it for the target user group to develop an accurate working mental model of the technology, so they can apply it effectively in their work?
5. **RELATIVE ADVANTAGE**. Compared to existing ways of doing work, what benefits does this bring? How much work is required for the technology to be useful?

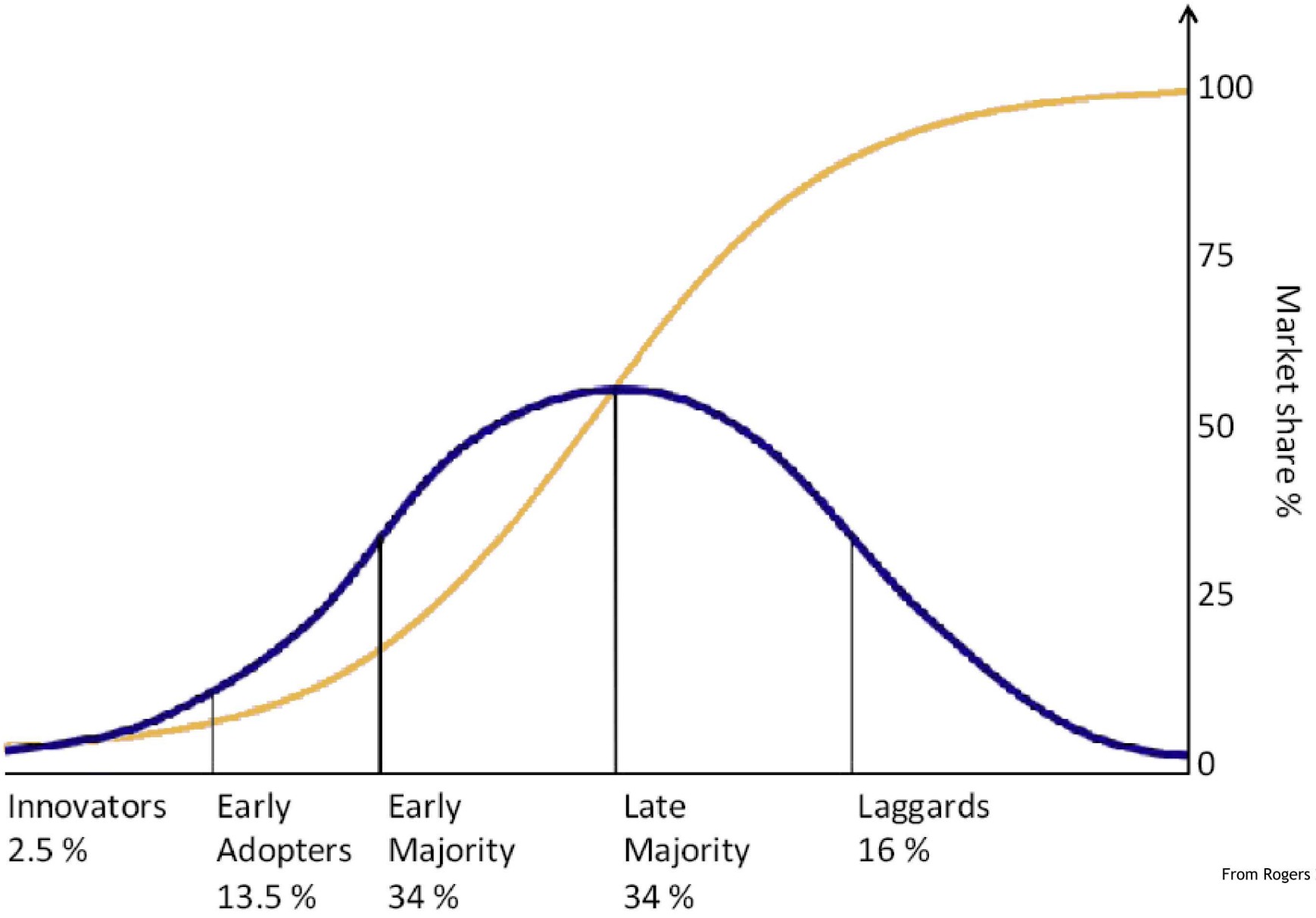
DIFFUSION IS EXPLORATORY DECISION-MAKING

Existing Context:

- Decision-making framework: Optional/individual, collective, or top-down (authoritarian)
- Social network and communication patterns
- Perceived/recognized need
- Individual differences

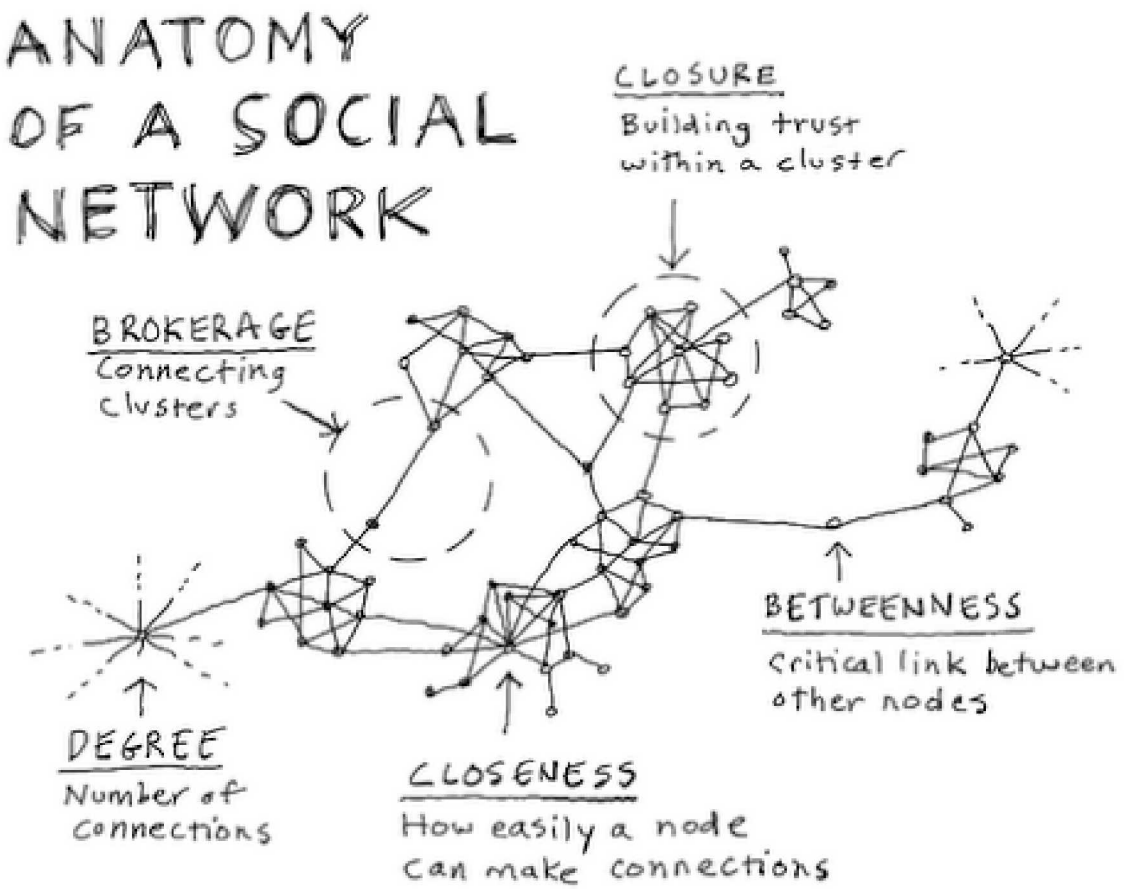
Knowledge	Persuasion	Decision	Implementation	Confirmation
Learn about the innovation, how it functions, who's using the innovation and why.	This is where the **innovation characteristics** come into play: visibility, trialability, relative advantage, etc.	Let's try it! (Adopt) Meh, not for us. (Reject)	• Continued integration into practice • Discontinue use. • Reconsider, revisit, try out • Confirm rejection.	

THE DIFFUSION S-CURVE

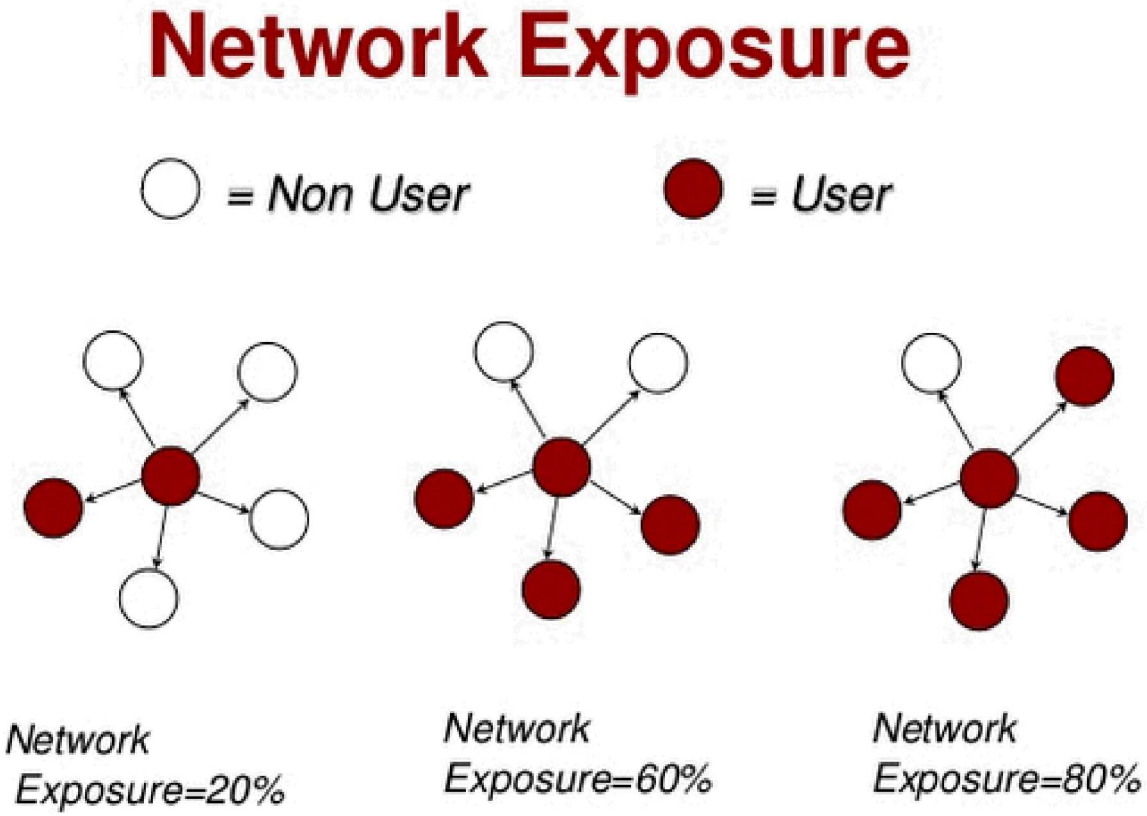


From Rogers 2005

PEOPLE *COMMUNICATE* ABOUT NEW TECHNOLOGIES



From Gray 2015 https://link.medium.com/7fxohSemG3



From Valente 2018

THINKING ABOUT ALGORITHMIC TECHNOLOGIES

TODAY'S THEMES

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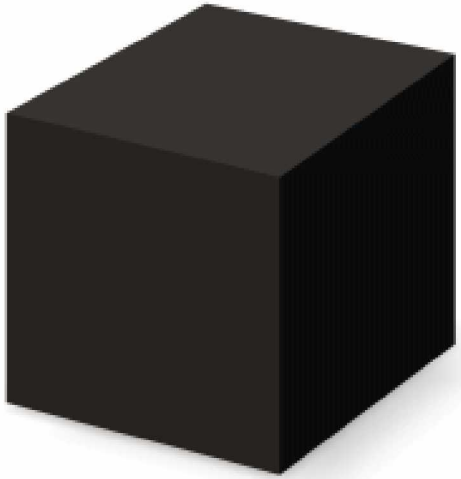
DATA PROCESS OUTPUT



"SORT OF, BUT THE SPECIFICS NEED ELABORATION."

1. **VISIBILITY**. The Black Box. Also, many organizations are drowning in new tools, so any specific algorithmic technology might not be as salient as we'd like.
2. **COMPATIBILITY**. Algorithmic technologies may not be immediately compatible with existing ways of processing data or delivering products.
3. **TESTABILITY.** Being able to try something out in parallel with one's existing tools/techniques can facilitate transition, but that's not always easy.
4. **COMPLEXITY.** The Black Box. How transferable is the knowledge that went into creating the algorithmic advance?
5. **RELATIVE ADVANTAGE**. My work is going fine. What are the risks, costs, benefits for investing the time and energy required to integrate this technology into what I'm doing? When it comes to new methods, what has my experience been in the past? What are others saying about this?

RECOMMENDATIONS

TODAY'S THEMES

- Most 'folk' models of innovation diffusion and adoption are incomplete.
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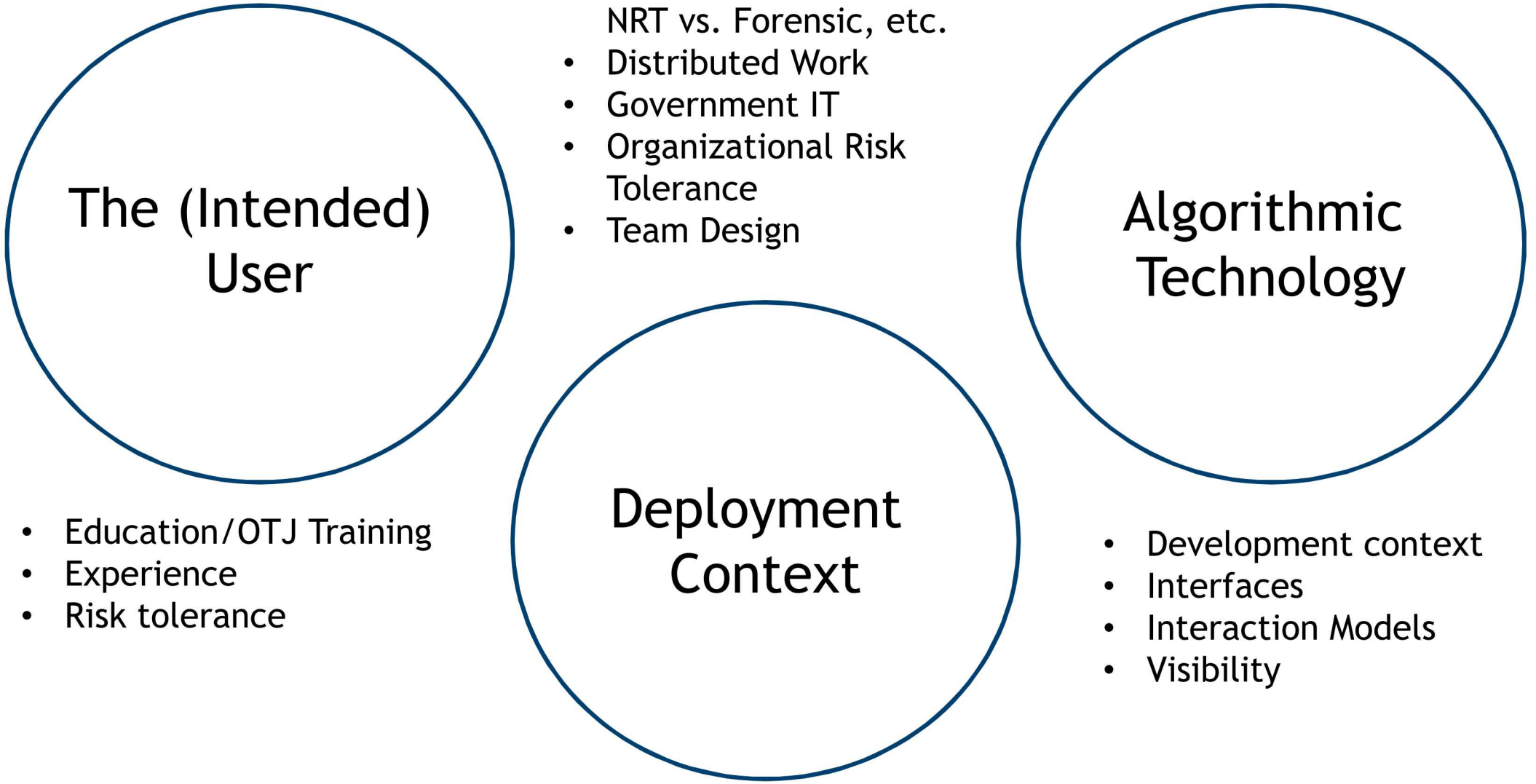
- Does this literature speak to emerging algorithmic technologies – including data science, information visualization, visual analytics – and their prospects for integration into existing workflows?
- If the answer is, "Sort of, but…," what should we be doing to address this gap? (HINT: The answer is, "Sort of, but....")

INTEGRATE & EXPAND DIFFUSION/ACCEPTANCE MODELS FOR THE NATIONAL SECURITY WORKPLACE



- Collection, Production, NRT vs. Forensic, etc.
- Distributed Work
- Government IT
- Organizational Risk Tolerance
- Team Design

- Education/OTJ Training
- Experience
- Risk tolerance

- Development context
- Interfaces
- Interaction Models
- Visibility


https://nerdist.com/article/star-trek-red-shirts-werent-statistically-the-most-likely-to-die-after-all/

GOING FORWARD

Within Sandia

- Establish a Community of Interest around innovation diffusion, technology acceptance, and –for algorithmic technologies – to examine the role of explainability/understandability in acceptance and integration.
- Case studies - recruit programs, inventors, LDRDs, projects to speak candidly about cool stuff that did – or didn't – transition as expected.

Across our sister laboratories

- Establish a cross-laboratory COI around diffusion, acceptance, adoption dynamics – within the national laboratory system
- Knowledge sharing workshops to discover, codify, and *evaluate* "best practices" for maturing our innovations into viable solutions

With our funding agencies, stakeholders, customers

- Does the literature on diffusion, adoption, acceptance, usage address the contextual particulars of large federal bureaucracies?
- Can we develop and validate a protocol for assessing whether a particular niche might be a viable environment for a young algorithmic technology?

CLOSING THOUGHTS

Recognize national security workplaces as uniquely challenging.

- The intelligence community is a multi-organizational, multi-technology *system of knowledge product (systems)*.

Challenge assumptions about intrinsic 'betterness' of our algorithmic technologies.

- If you find yourself thinking, " OMG I can't believe they're using Excel," turn it around. "What functions does Excel provide in this workflow?"
- Replace "If they had (x), they could find a lot more in their data," with "If I were an analyst in this group, what would I be doing every day, why, and for whom?"

Calibrate our collective expectations about viability and adoption for any particular "invention."

- What's realistic for this Thing, given a) the current TRL and b)where we envision it being applied?
- What can we do as an organization to support the maturation and transition of this technology into a viable niche?
- Facilitate learning, low-risk exploration, and – when it's merited – disinvestment.

THANK YOU