CHANGING WHAT'S POSSIBLE

Well, Now What?

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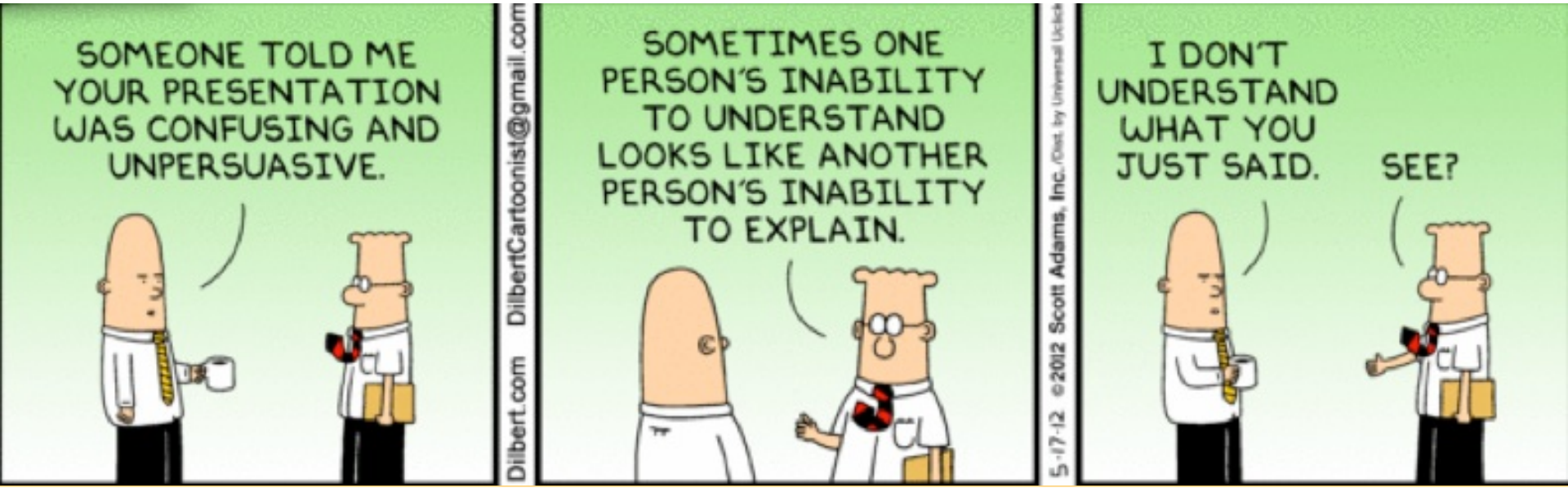
ARPA-E Workshop
May 16, 2019

Outline

- Recap and major observations from day one
- Some framing about ARPA-E programs
- What are we trying to do today?



Motivation

- We know the existing fleet is shutting down from high O&M costs, comprised largely of actual O&M (staffing)
- And we want reactors for now and the future
- Advanced Reactors will have larger capital costs in their LCOE, but O&M is still substantial
- Perhaps more importantly, they mostly haven't thought about O&M
- And Now *Is* the time to define and develop the needed approaches and technologies

What Can We Leverage From Right Now?

- We can see how much data we can use from the existing fleet to inform ARs, especially BoP (note: this is a hard proposition)
- We can learn what we could do differently
  - Make data collection easier (integrated, accessible, navigable)
  - Make items self-reporting and self-diagnosing
  - Stop taking apart functioning pieces of equipment


Mark Bugnaski / Kalamazoo Gazette

From a survey of 350 nuclear industry experts as reported in
Market Report: the future of nuclear digitalization (Nuclear Energy Insider, 2017)

What Might "Optimal Operations" Mean?

- Lower direct personnel costs
- Eliminate radiation to workers
- Reduce cost / amount of maintenance
- Reduce risk of human error
- Increase operational excellence
- Increase margin / safety envelope

- Letting non-safety critical components run to the edge or even fail
- Iterative sensor deployment – model refinement
- A "one-size-fits-most" O&M plan for BoP

Some Key Points From Day 1

This is Not a well-defined problem space

- APM must start with the value proposition
  - What is it really for?
  - What do we really need to measure?
- There is real value in a different sensor frame:
  - Iterative design
  - Using sensors/hardware we have to infer
- Test loops for different coolants are out there: leverage them
  - Data
  - Try out maintenance
  - Try out models
- What do we really need to know?
- How Well?

Some of My Thoughts

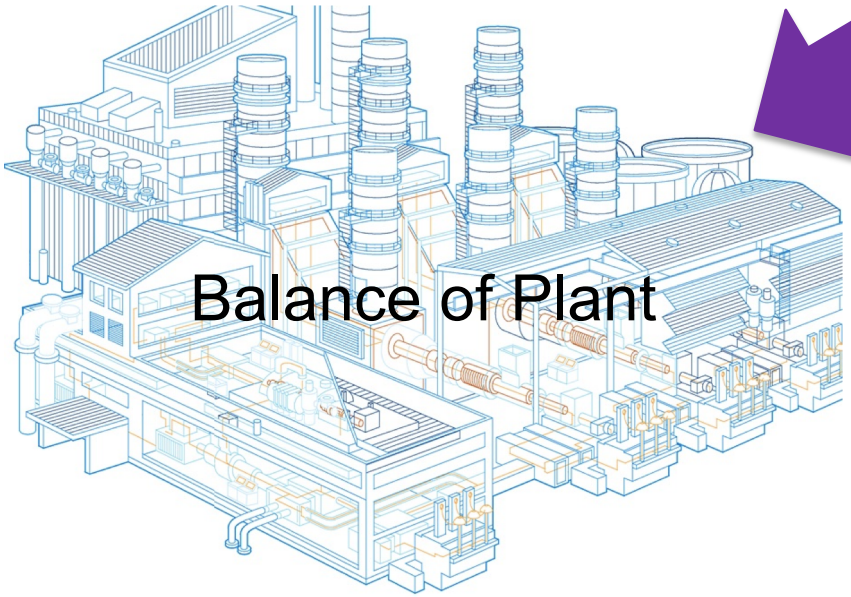
Framing the safety case:

- Consider reactors that don't have offsite accident consequences
  - Choices are about asset protection
  - Not about public health and safety
- What are the real impacts of unpredicted / incorrected outcomes? What are the tradeoffs of learning vs. perfection?

Reminder: we –aren't– going to focus on security as a main initiative. If there are key technology gaps you think we should be addressing, please do bring them up.

Some of My Thoughts

- What about designing interface requirements?
- What about high-level frameworks that let us experiment?



Advanced Reactor Core

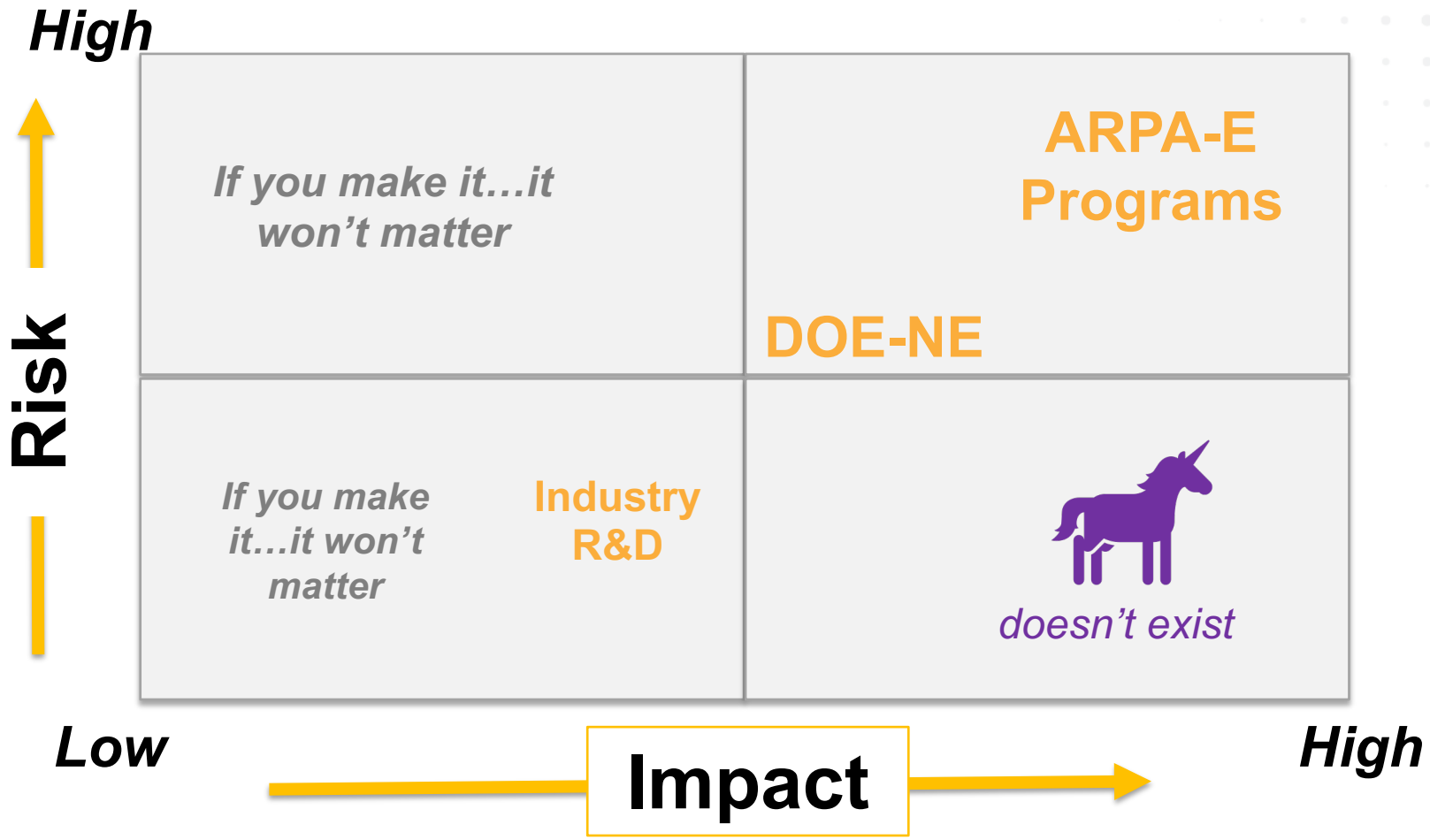
- What do we need for digital twins on both sides of this line?

Tell Me About ARPA-E Programs

- Statute includes basic science up to pilot-scale projects
  - Though *most* of our funding is in the between space
- Typically 3 years in duration
- Minimum project size $500k, Maximum $10M

- Programs informed by RFIs and Workshops
  - I'm aiming to have a FOA by late summer (should this get approved)

What We Really Want Out of This



We Want Your Input On Program Details

What program structure would best accomplish the goals?

How would you define success for this program?

What should the program goals be?

Which topics should we fund and what would be aspirational targets to hit over the next 3-5 years?

Strawman Program Motivation and Goals

Overall goals:

1. Have a clear understanding of the technical requirements for O&M for several Advanced Reactors
2. Reduce fixed O&M cost from ~13 $/MWh in the current fleet to ~3 $/MWh in the advanced fleet

Most likely path:

1. Translate existing technologies to advanced reactor designs and develop technologies to fill in the gaps
2. Reduce total staffing level from ~750 FTE/GWe to ~50 FTE/GWe

Strawman Program Structure

A program structure could ask each performer team to do one of the following for an advanced reactor design (or even better, a collection of advanced reactor designs):

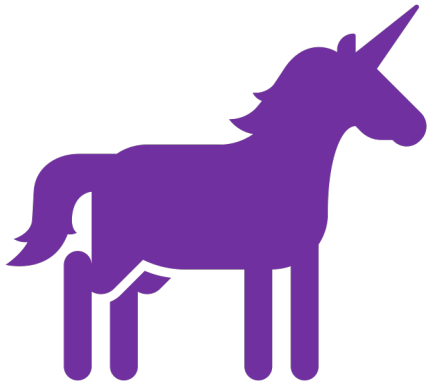
1. Develop and test the technology to automate one complex maintenance task.
2. Develop and test a plan for APM to reduce the cost and/or time burden of maintenance by 90%.
3. Develop and test the enabling technologies (e.g., sensors, controls, verification and validation approaches) to make reactor control substantially autonomous.

Next Up

We'll hear from NE so we know what more about what they're already doing

I'll remind you about what I just said, and then we'll have a breakout so you can help us figure out how to deal with this really hard problem space.

(What is the map to get to
to the unicorn?)



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