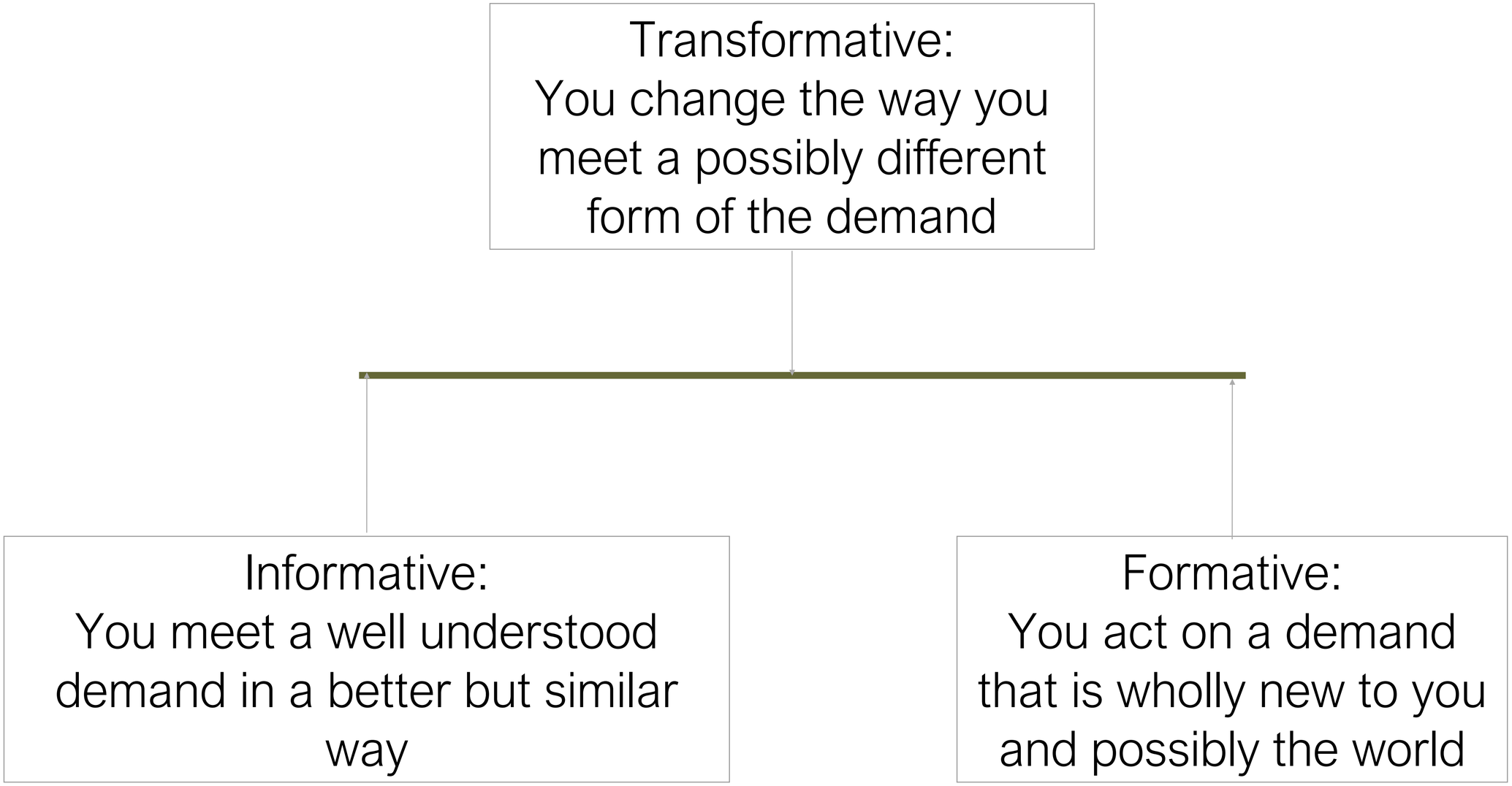
Federal Technology Outlook

When can we predict technical progress — A joint thought piece from Mark Wegman based on work with Danny Sabbah (retired IBM) Merrick Furst (Center for Deliberate Innovation(CDI) and Matt Chanoff(CDI)
See our first paper: https://cdi.gatech.edu/TowardsDeliberateInnovation.pdf

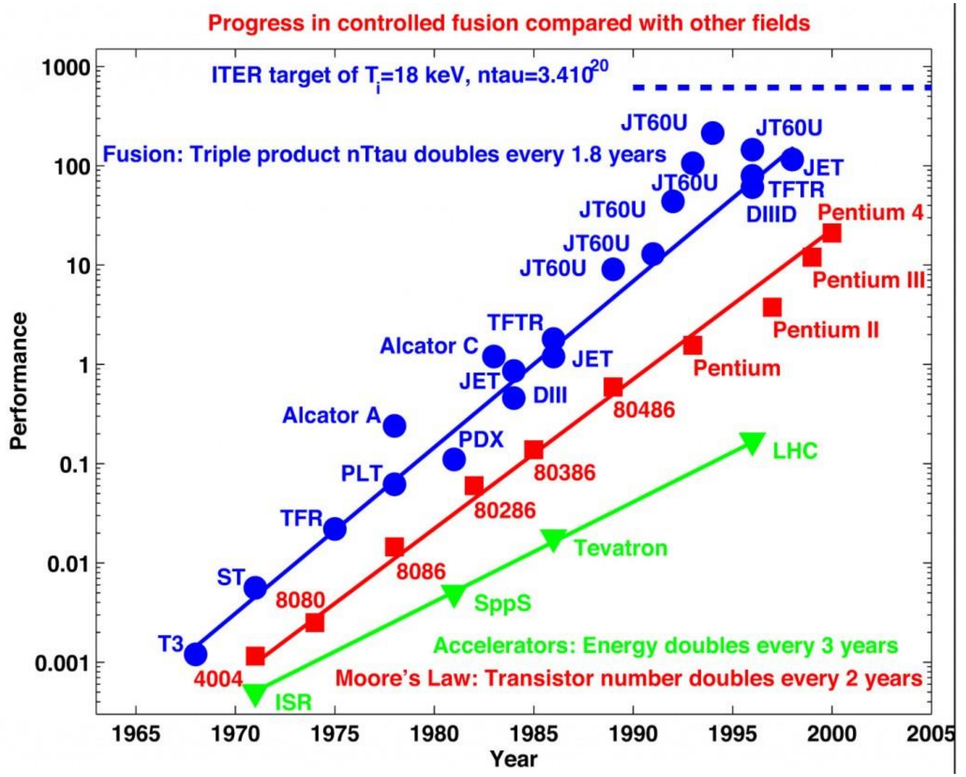
In the late 1970's IBM Research began to produce a Ten Year Outlook

- The message of the first was Technology was moving straight ahead.
- When we looked back at it ten years later it was remarkably accurate
  - But as we continued we found that while the materials and devices people were amazingly accurate, on the software side we missed major things (e.g. that spreadsheets would come about and make a big impact on the acceptance of PCs and the like.)
- This talk will attempt to shed light on when you can and when you can't predict progress and some of the underlying causes


Transformative:
You change the way you meet a possibly different form of the demand
Informative:
You meet a well understood demand in a better but similar way
Formative:
You act on a demand that is wholly new to you and possibly the world

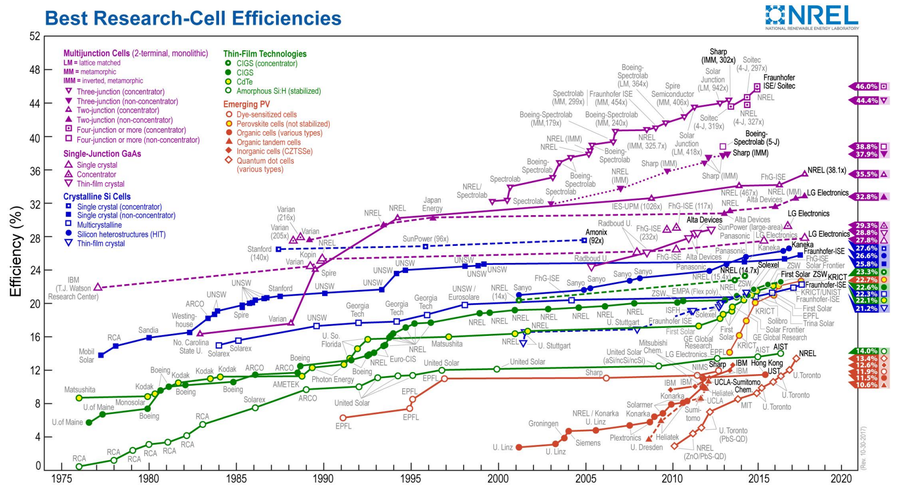
Lawson Criteria: Heat x Density x time in a fusion reactor

Determines whether we get more power out of a Tokamak than we put in

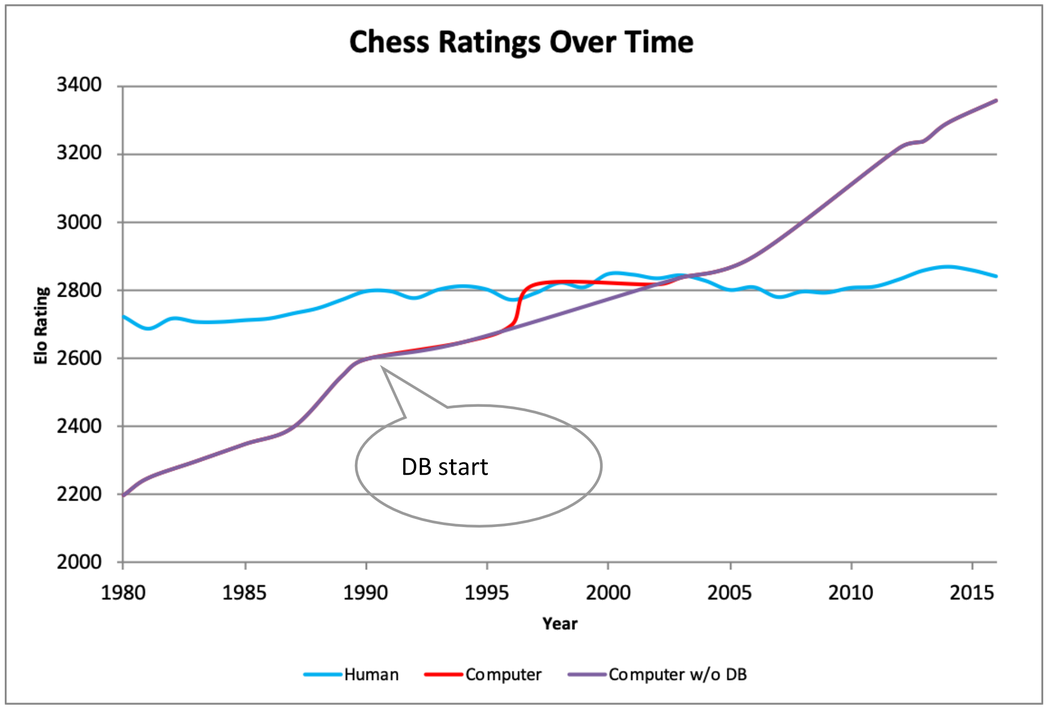


Efficiency of photovoltaics

You can get more efficiency by using more process steps to make the cells. The cheapest may cost too much installation, so the right answer is somewhere on one of these curves. Some of these hit asymptotes and people switch to a new technology.



Bending the Curve



We started the DB project in 1990, had a very smart team Able to do things our competitors couldn't and had a different object than they did. We bent the curve but not by much.

A similar story holds for

- The max speed of a car in the 1900's
- Rechargeable batteries (Density x log(Number of charges) x etc) also all renewable technology e.g. windmills
- Deep learning's ability to recognize images correctly
- Cost of chemical manufacturing
- Many more
- Why does it work in these examples?

Two parts to informative technology innovation

- Development of the underlying technology
  - Example developing a vaccine
- Deploying the technology massively
  - Example manufacturing and shooting vaccine into arms
- One involves a relatively few highly skilled people and the other massive numbers

Preconditions for successful curve fitting about quality of solution

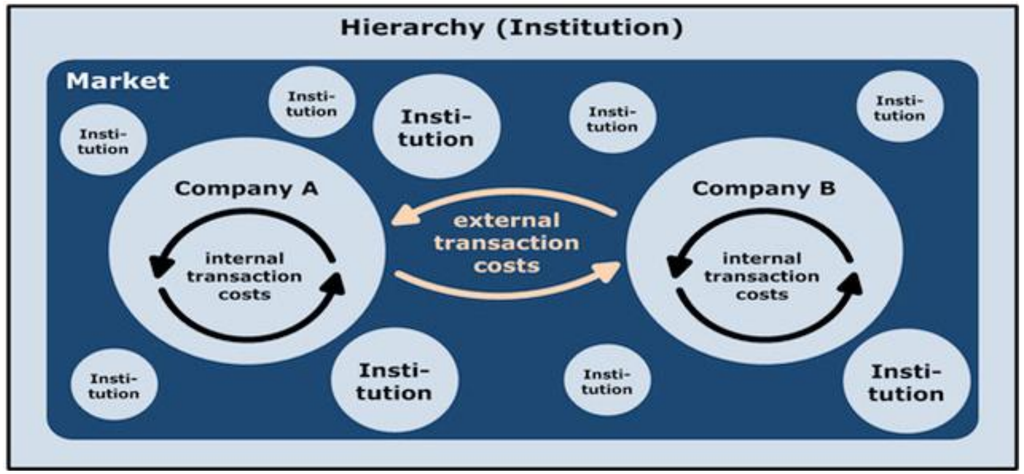
- Enough people working on the problem
- General agreement about what the problem is and the desirability of solution (informative phase)
- Putting more people on the problem improves the speed to a better solution in a sub-linear fashion (see Brooks Mythical Man-Month)
- No insuperable problems (e.g. making a line smaller than an atom). No other technology that's growing faster that disrupts the curve.

Conway's Law

- States that Code and the organizations that produce the code mirror each other
  - Code reflects architecture reflects organizational structure (flatter, smaller)
- People (and organizations) now program by finding code snippets on the web and in the future will increasingly (search) find services with QOS
  - Services get better over time, because you aren't finding code you are finding an organization that will support and improve it (business models)
  - API's/Denotational isolation means redeploy and maintenance is minimal.
  - Consequences of trust that improvement is more likely than breakage. Needs discipline with API's etc. making 'heterogeneity' in programming possible (hence massive emergence of scripting)
  - As Organizations change via changes in Coase's transaction costs Software organization changes

From “The Nature of the Firm” (Coase)

Transaction cost theory tries to explain why companies exist, and why companies expand or source out activities to the external environment



Transaction costs can be divided into three broad categories:

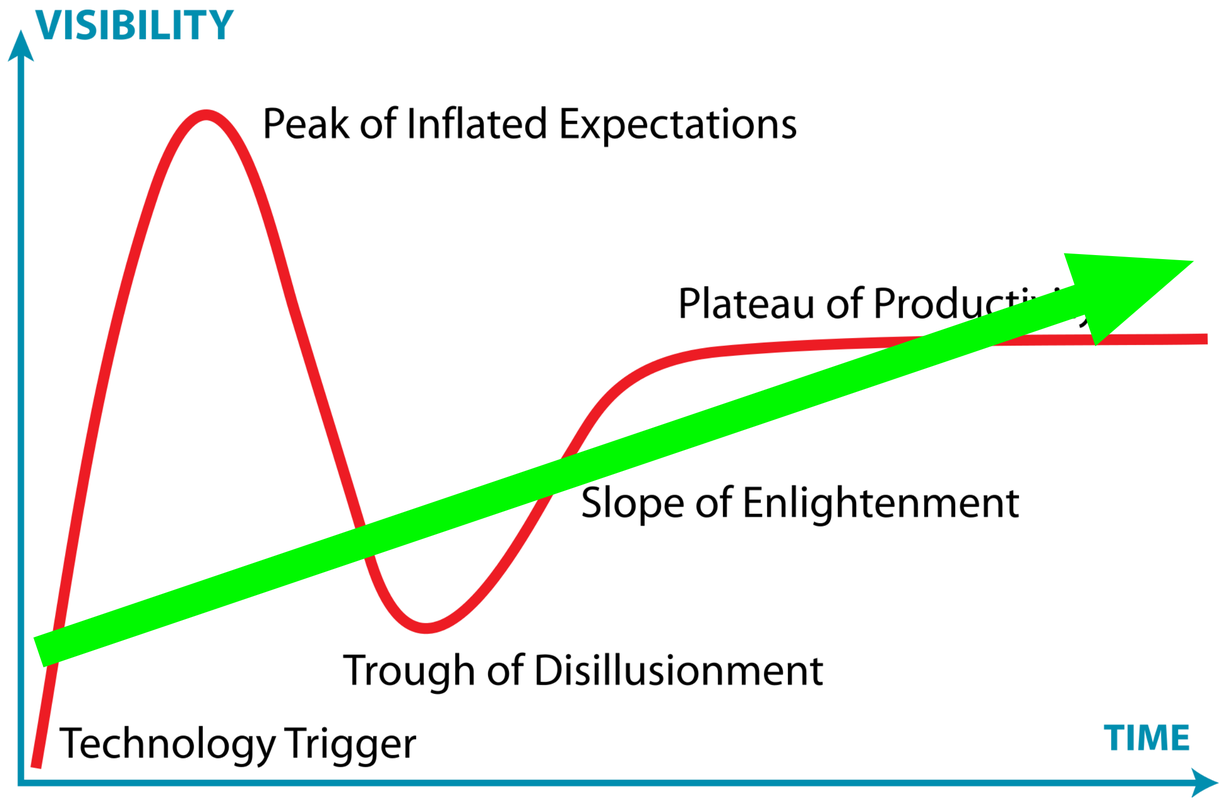
- Search and information costs
- Bargaining costs
- Policing and enforcement costs

Deployment of a solution

- Often super-linear in the resources expended (e.g. it might take one person to make one widget in a month, two people can make four widgets and three can make nine. In part because if you make more you optimize the process and build tools/machines to make it go faster. Also marginal costs are cheaper once the initial product is created.

- Because it's super-linear it can be less predictable and costs can be more subject to market conditions. But increases the competitive pressure to get to market first.

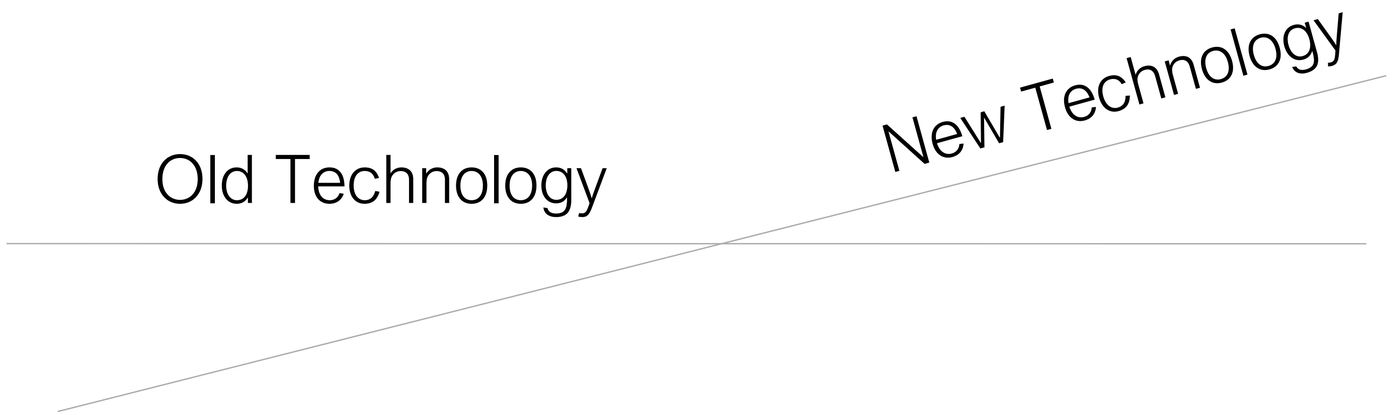
You don’t want to invest too much too soon, but if you are late Brooks effect makes it hard t



Optimal Investments
Slow and steady wins the race

Hype comes because people assume more Resources will speed things up

Tipping Point



When does Curve Fitting fail badly?

Remaining slides taken from my colleague Merrick Furst at the Center for Deliberate Innovation at GaTech.

Frequency of Innovation Success?

A: 90%

B: 10%

C: 1%

D: 0.1%

E: Nobody Knows

Causes of Innovation Failure?

NO DEMAND

NO TIME

NO TEAM

NO TECHNOLOGY

NO BUY-IN/ SUPPORT

BAD LUCK

Errors in Judgement
In Context of Innovation

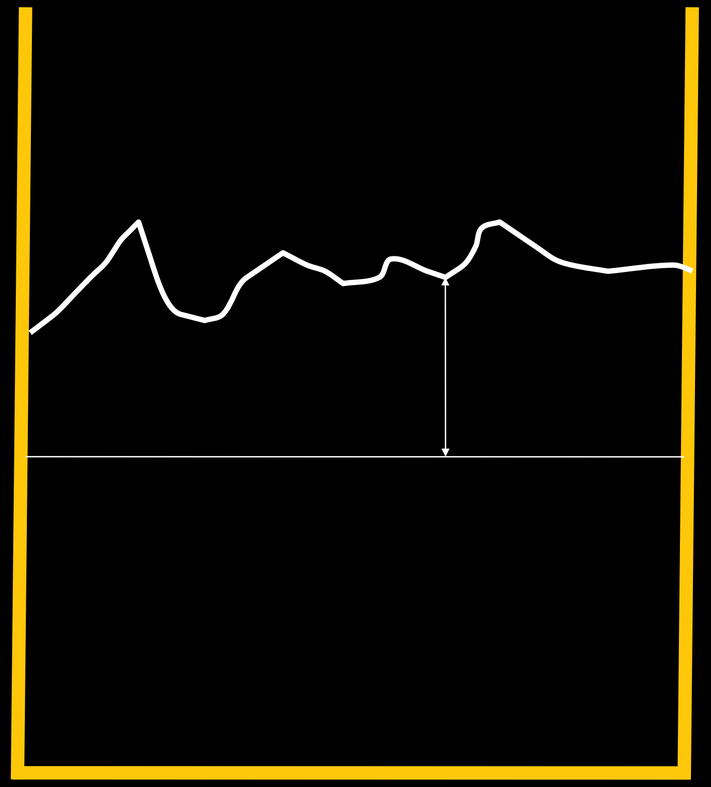
BIASES **and** **BLINDSPOTS**

Confirmation Bias
Hindsight Bias

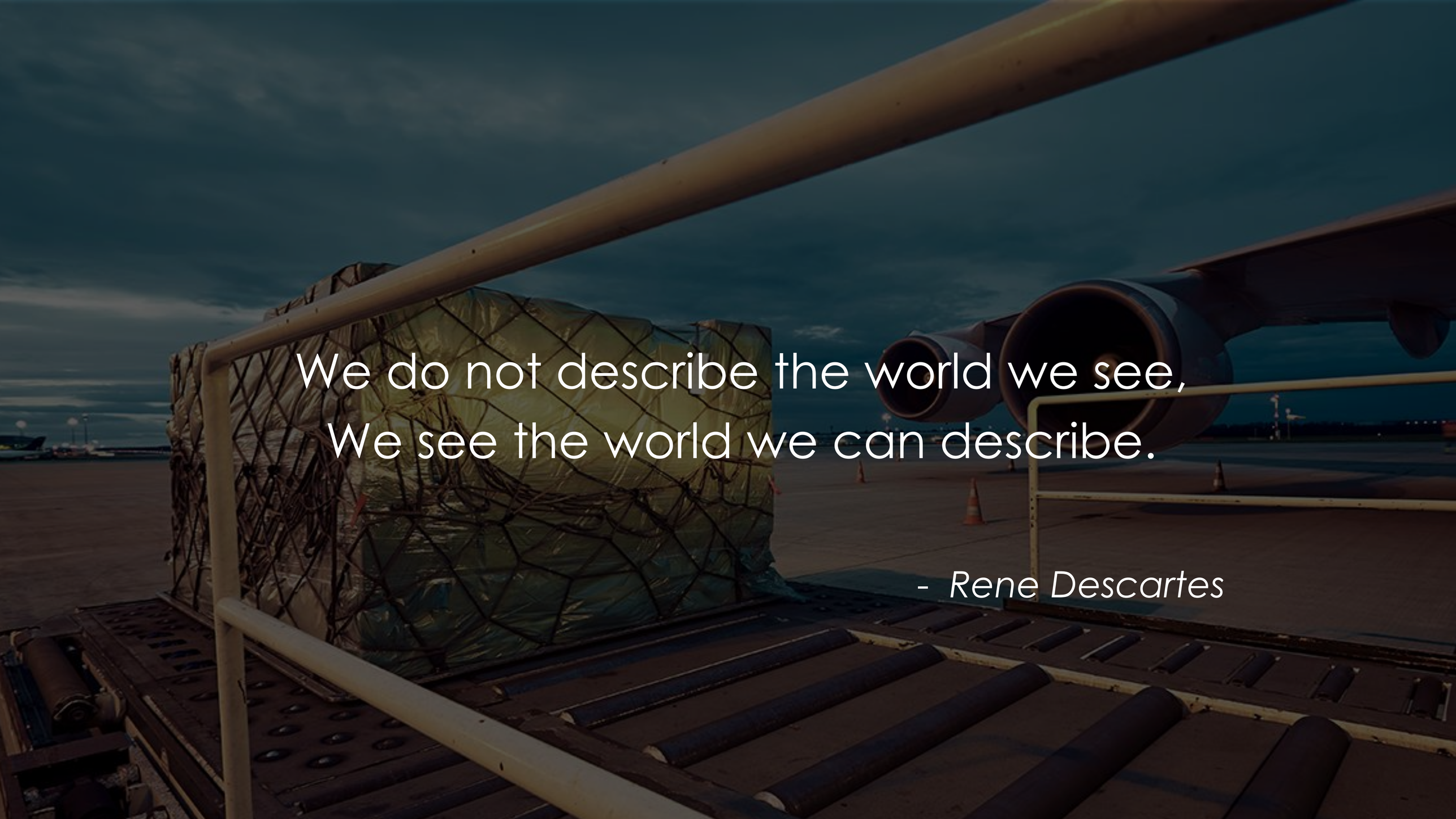
Leading Questions
Misinterpret Conversations

3 Distinct Types of Innovation


We don't see things as they are;
we see them as we are.
Anaïs Nin



Informative


We do not describe the world we see,
We see the world we can describe.
- Rene Descartes

Most Companies Spend time in Informative Demand

Moore's law is a classic case.

Getting to this point and being one of the leaders is a Good thing.

IBM and most big companies are good at this.

Transformative

Websphere

IBM's customers in the 90's needed to change to produce code that enabled their customers to interact with their data systems directly instead of talking to an employee of the company who would enter their data.

This meant IBM had to partner with open source efforts and build a big tent, where IBM previously had only built proprietary products.

But we talked to the same customers with the same salesforce.

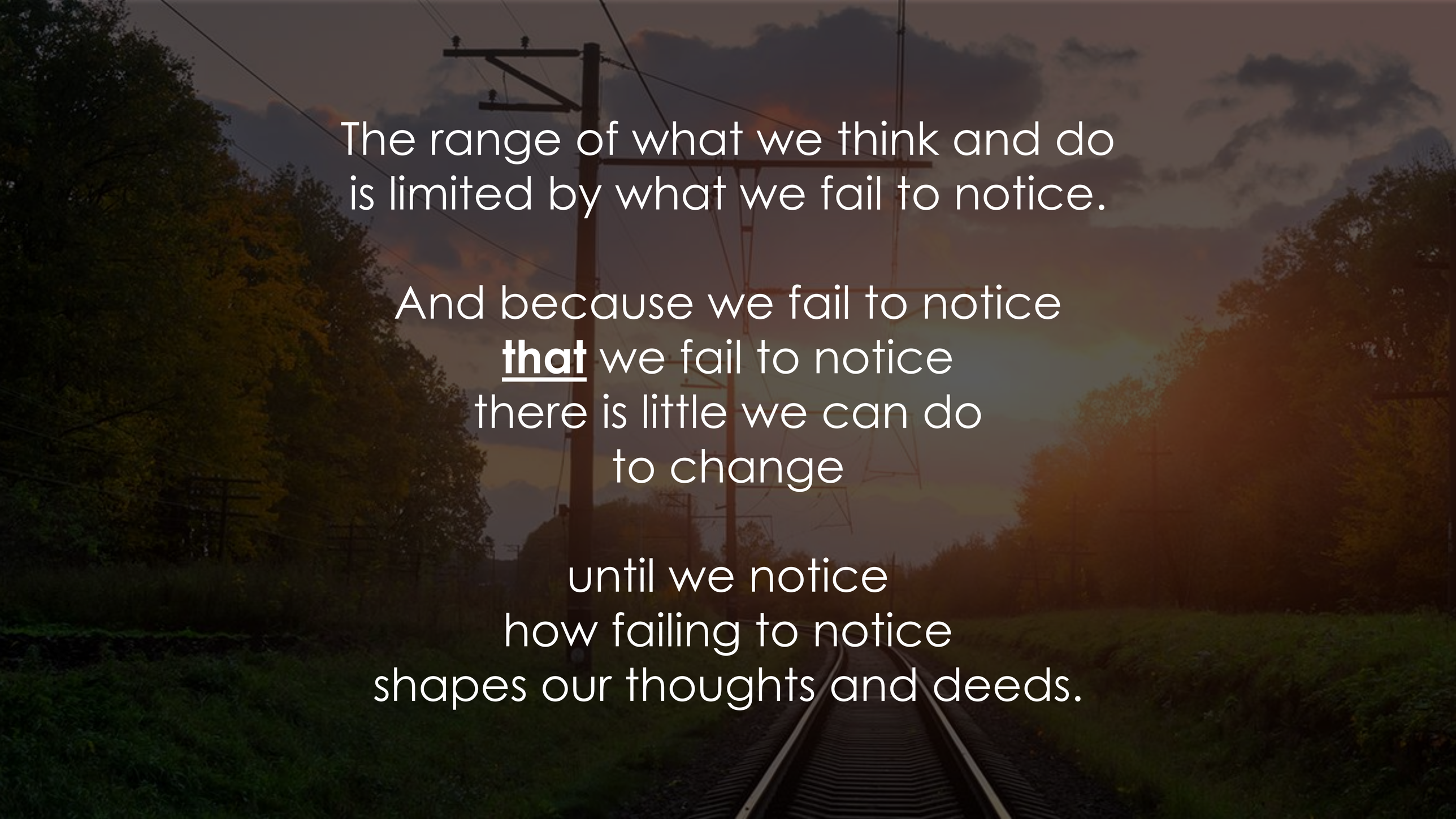
Government Examples?

Haven't thought as much about this, but:

- The EPA going from Obama to Trump to Biden
- The Navy prior to WWII looking at aircraft carriers vs destroyers

In both these cases you get similar resistance to change that you get in businesses attempting to address a change in the shape of the demand.

Mark's personal opinion



The range of what we think and do
is limited by what we fail to notice.

And because we fail to notice
that we fail to notice
there is little we can do
to change

until we notice
how failing to notice
shapes our thoughts and deeds.


Formative

IBM and the PC business

Switch from talking to CIOs who knew their main computational need to individual customers who wanted a PC but didn't know what they were going to do with it.

Required the formation of a new entity in IBM, and was driven by the CEO. Completely different sales model. But customers felt good about IBM because we were trusted

Government examples?

NASA Government had never had a mission to go to the moon. Required a completely different organization with different work models.

Obamacare???? Building the health care web site was certainly something the Federal Government wasn't used to. Building a marketplace wasn't either.

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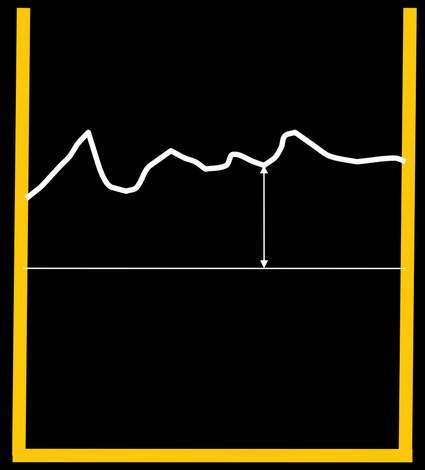
Formative



Informative

Transformative