

# Reducing the knowledge gap

(taking stock from FORCES experience)

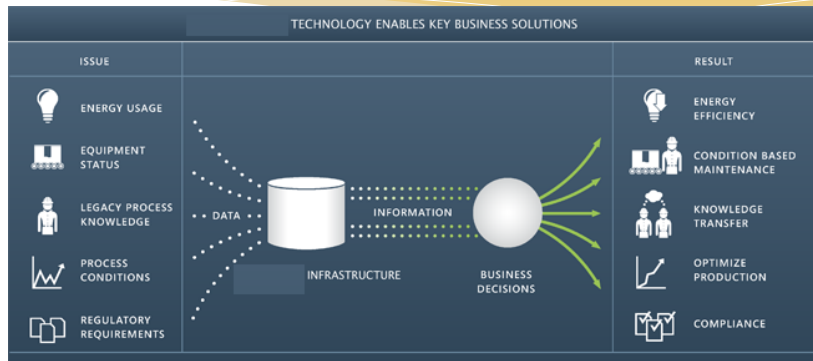
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## Motivation Disjoint Perspectives?

The topics  
Bits of History  
Institutions  
Present  
Future

# Critical Infrastructures: Towards resilient CPS



How **engineers** and **economists** approach CPS resilience?

# FORCES objective: to combine (RC) & (EI) tools

The conundrum of integrating largely disjoint perspectives

**Engineers (RC):** (almost) everything should be (nearly) efficient

**Economists (EI):** (almost) nothing is efficient

I review economic concepts & results for CPS scholars

public goods, regulations

two-sided platforms

contracting with asymmetric information

risk management

- microeconomics & contract theory
- industrial organization (IO) & public economics and regulations

**The goal: to identify synergetic problems;  
Develop both education and research at the interface of RC and EI**

# Engineers and Economists: the differences

What drives information exchanges?

Engineers



technology  
speed of data transfer

Economists



incentives  
private objectives

# Human Factor is FOCAL: 10 smart Engineers

PRODUCTS

TECHNOLOGY

CUSTOMERS



NEWS & EVENTS

Events

Newsroom

NEWSROOM > MARCH 6, 2015

GREENTECH MEDIA

## C3 ENERGY CEO: 10 SMART ENGINEERS COULD BRING DOWN THE GRID 'IN 4 DAYS'

By Julia Pyper

Democrats, Republicans and energy industry leaders agree that the electrical grid is the most important engineering achievement of the 20th century. Where there's some confusion is around how to ensure a more secure, reliable and advanced electricity system for the 21st century.

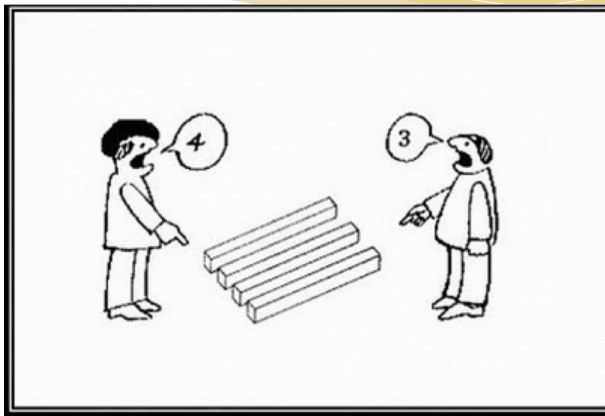
"The challenges are significant -- much of our grid is outdated; coal-fired generation facilities are shutting down at an alarming rate; reserve margins are inadequate in several regions; intermittent and remote renewable capacity is coming online; and cyberthreats pose a growing concern," said Rep. Ed Whitfield (R-Ky.), chairman of the House Energy & Commerce Committee, at a hearing this week.

The numbers are stark. More than 50 percent of generating capacity in the United States is more than 30 years old. More than 70 percent of the 280,000 miles of transmission lines are more than 25 years old. More than 50 percent of the 2.2 million miles of distribution lines are more than 30 years old. And it costs \$90 billion per year to keep the whole network running.



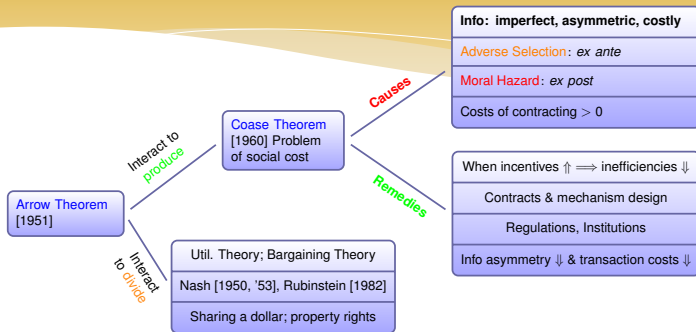
# Engineers and Economists: the similarities

## Engineers and Economists



are almost identical  
both professions are quantitative

# Teaching plan: From Arrows theorem to Econ of Information



We will make no distinction between **TRANSACTION COSTS** & **CONTRACT COSTS**

**Our focus: to be ready to work with column III**

- modeling asymmetric info and costly contracts  
Asymmetric info and contractual costs: any relationship?
- risk & decision making under uncertainty



# Outline

Motivation

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# Travel through Time I

## From prehistoric era: Nobel'71

- **Paul Samuelson** Equilibrium theory (partial & general eq.)

## To ancient times: Nobel'72, '91

- **Arrow** Impossibility Theorem
- **Coase** Transaction costs, property rights, institutions

## To modern times: Nobel'94 Nash, Harsanyi, Selten

- **Nash** Equilibria, Bargaining Theory, Game Theory
- **Harsanyi** Bayesian games [tools for richer info structures]
- **Selten** Equilibrium refinements, multi-stage games

## Spring 2015

We discussed Nobel'72,91,94 and started asymmetric information

## Spring 2016: we continued the time travel

## Nobel'2001

- **Akerlof** Information Imperfections [Lemons]
  - Missing Markets
- **Stiglitz** Markets with Asymmetric Info
  - Grossman-Stiglitz impossibility result
- **Spence** Signaling

## Nobel'2007

- Maskin Implementation
- Myerson Mechanism Design
- Hurwicz Enforcement

## Nobel'2014 Analyzing Institutions, Markets and Information

- Tirole A footprint on everything [no unifying theory yet]
  - Regulatory economics: market power and public goods
  - Incomplete contracts
  - Platforms (networked environments)

## Valuation of Derivatives: [attn Pricing Risks]

- **Scholes'97** Valuation of derivatives
  - from Ito calculus to Black-Scholes formula [Samuelson was close ...]
- **Merton'97** Applications of Black-Scholes

## From Coase to Institutions to Governance

- **North'93** Theory of economic institutions
- **Williamson'2009** The firm and its boundaries
- **Ostrom'2009** Organization of commons
  - public infrastructures & property rights

## Nobel'72, 91, 94, then Nobel'97, 2001, 93 & 2009, 2007 & 2014

- Merton, Scholes'97 Value of Derivatives [= Pricing Risk]
- Akerlof, Stiglitz, Spence'2001 Asymmetric information
- North'93, Williamson & Ostrom'2009 Institutions: theory, design and governance
- Maskin, Myerson, Hurwicz'2007 Implementation, Mechanism Design, Enforcement
- Tirole'2014 Regulations, market power, networks, contracts

## Hot topics today & tomorrow: Information and Risks

- **Practical** Issues in implementation, robust implementation
- **Limits** of Mechanism design
- **Information** in games, global games, big games
- **Tomorrow?** Risks in networks, institutions [why?]

## Glancing into the future: synergetic areas for RC+EI

- **Contracts, Enforcement, Institutions** Costly contracts revisited
- **Institutional design** from theory ['96,2009,2014] to practice
  - Infrastructures (CPS): design
  - Cyber security (CPS): pricing the information
  - Resilience to risks (CPS): liability for information goods
- **Cyber-risks** from valuing the derivatives ('97) & information ('2001) to managing cyber-risks
  - cyber-risks (CPS): evaluating and pricing risks in smart cities
  - cyber-risks (CPS): management (incl. cyber insurance)

# Outstanding challenge for RC+EI

## Cautious optimism WEF reports: Global risks 2015, Global risks 2016

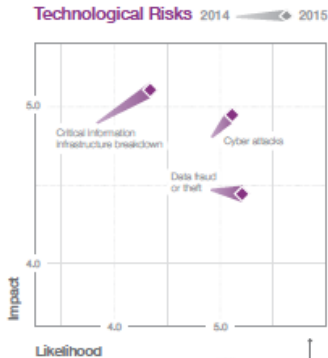
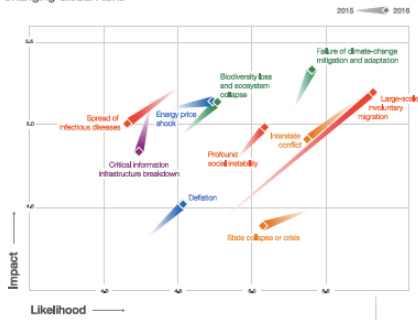


Figure 1.1: The Changing Global Risks Landscape 2015–2016: The 10 Most Changing Global Risks



Reduced prob. (& exp. losses!) from critical info structure breakdown