Energy RD and Policy: "Embracing" Failure

John F. Kennedy School of Government
Cambridge, Massachusetts
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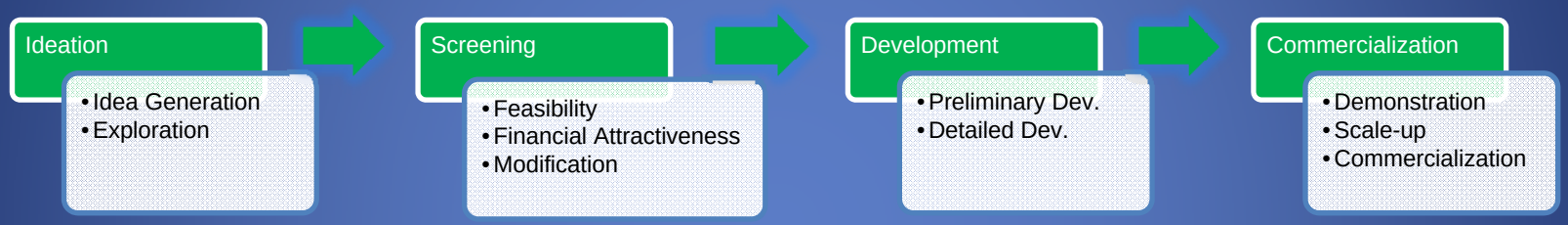
Creativity, Innovation and "The Six Levers"

- **Creativity – Generating and Developing New Ideas**
- **Innovation – Bringing Ideas to Market**



The Six Levers of Innovation

Constancy of Purpose in Technology Programs

Adhering to Aggressive Development Goals

Using Broad/Multiple Approaches

Increasing Focus vs. Spreading Thin in Business Extensions

Upgrading Adequacy of Science Base

Achieving Business/Technology Interspersing

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Innovation Systems

Ideation
- Idea Generation
- Exploration

Screening
- Feasibility
- Financial Attractiveness
- Modification

Development
- Preliminary Dev.
- Detailed Dev.

Commercialization
- Demonstration
- Scale-up
- Commercialization

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Failure and Its Basis

Fact ***– violating the laws of thermodynamics***

Knowledge ***– inadequate / incomplete information***

Learning ***– inadequate / incomplete assimilation of knowledge and facts***

Complexity ***– unpredictability of the interactions and responses of all internal and external agents***

The chief cause of technical failure is ignorance of fact or lack of knowledge

The chief cause of business and policy failure is complexity coupled with a lack of adaptive learning

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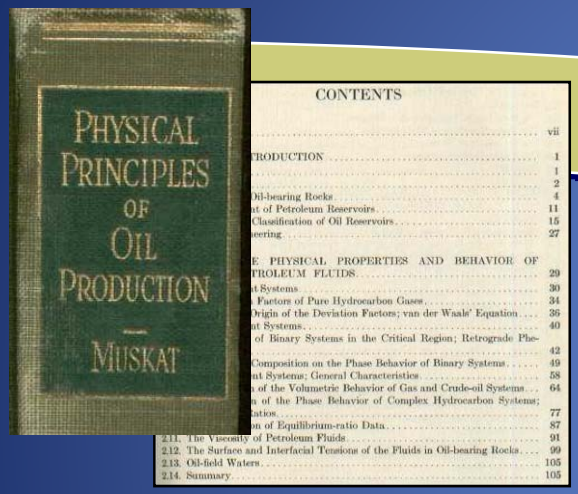
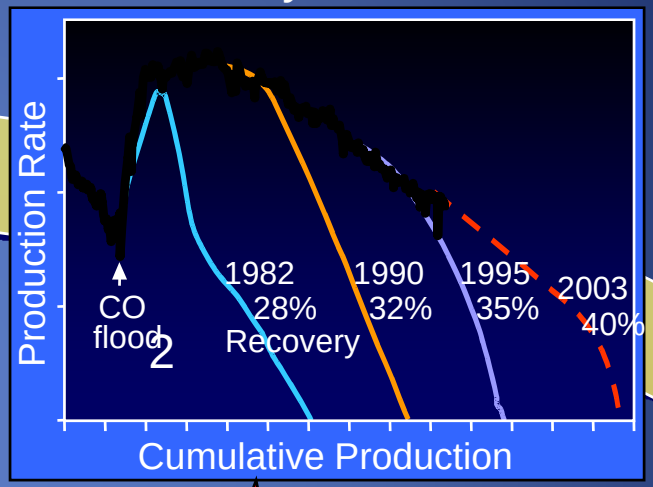
Optimizing Reservoir Recovery

Birth of Reservoir Engineering

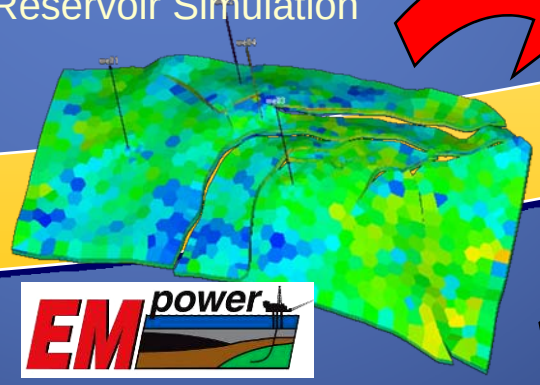


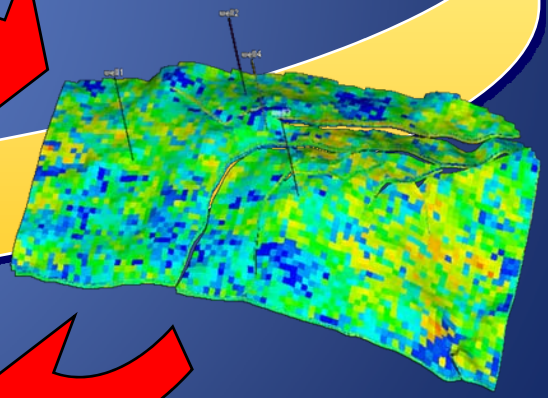
Analog to Digital Simulation

Enhanced / Improved Oil Recovery



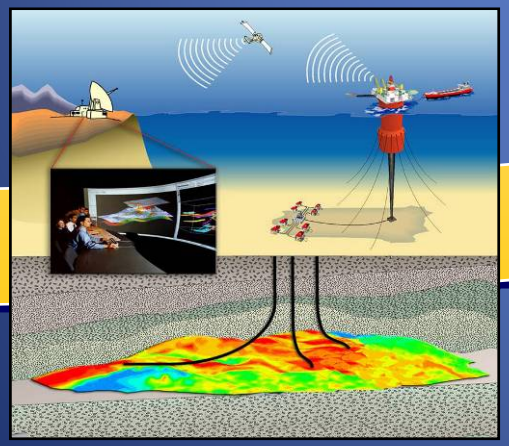
Reservoir Simulation





Geologic Model

Integrated Geologic Modeling and Reservoir Simulation



Real-Time Management and Optimization

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ExxonMobil

A World of Portfolio Choices

oil shale (evaluation), biodiesel and biofuel research, coal gasification, carbon capture and sequestration, lignocellulosic biofuels, wind (evaluation)

ConocoPhillips
Energy for tomorrow

tar sands, tight gas, LNG, gas to liquids, advanced vehicle systems, hydrogen production, carbon capture and sequestration (evaluation), cogeneration, freight transport efficiency, methane emissions

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LNG, tar sands, coal gasification, carbon capture and sequestration, tight gas, solar, wind, hydrogen, lignocellulosic biofuels

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gas to liquids, tar sands, LNG, geothermal energy, biodiesel, hydrogen production, lignocellulosic biofuels, solar power, coal

Chevron
Human Energy™

oil sands, oil shale, tight gas, solar, wind, coal gasification, gas to liquids, lignocellulosic biofuels, CO_2 capture and sequestration

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Portfolio Objective

Objective:

Achieve an *optimal* balance of :

- **Commercial success – revenue, earnings, cash flow, return on investment**
- **Sustainable competitive advantage – long term viability**
- **Risk**

The preference for *Optimal* Balance over the *Optimum* Balance reflects two essential realities:

1. **The complexities of the operating environment**
2. **The unpredictability of failure**

These Two are Coupled and the Core Subject of This Talk

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Why Most Things Fail

Observations

- **After initial start odds of business failure are size independent**
- **For the top 100 firms between 1912 and 1995 "…disappearance or decline was almost three times as likely as growth"**
- **Corporate failure follows a power law expression entirely analogous to biological extinction**

Conclusions

- **Despite our unique ability to anticipate and plan extinction is as pervasive a feature of business as it is in biology**
- **It is "as if" firms acted at random to achieve goals – and often fail**
- **The underlying cause is massive uncertainty and complexity**

Ormerod, P., "Why Most Things Fail: Extinction, Evolution and Economics", J. Wiley & Sons, New York, 2005

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The Role of Complexity

- **Failure arises as an outcome of the complex interactions between interconnected agents: firms, consumers, regulators**
- **The magnitude of effects is not predictable by the size of the perturbation**
- **Businesses and biological systems exist in complex dynamic environments and their ability to understand them is limited**
- **Adaptive strategies must be rapid and robust**
  - **Failure is to be expected and learning from it should be planned for as a adaptive strategy**

"…*Intent* is not the same as *outcome*…"

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Learning and Adapting

- **Humans learn from experience and adapt by projecting into the future – prospection – simulation**
- **Accurate prospection requires similar consequences and contexts in both present and future – rarely achieved**
- **Consequently simulations are:**
  - ***Unrepresentative*: we chose the worst or best case to epitomize the past *experience that informs future prospection***
  - ***Essentialized*: we ignore facts that *at the moment* don't seem relevant**
  - ***Abbreviated*: we tend to emphasize the short term consequences of events *in the future* both positive and negative – we don't expect to adapt**
  - ***Decentralized*: we underestimate the influence of *present* and *future* contextual factors on the desired consequences in prospection.**
- **Sharing and testing simulations with others may improve accuracy**
- **Explicit models are a powerful tool for sharing and testing prospection**
  - **Testable, expandable, adaptable**
  - **Source of key metrics**

Gilbert, D. and Wilson, T., "Prospection: Experiencing the Future", *Science*, vol. 317, no. 7, September 2007.

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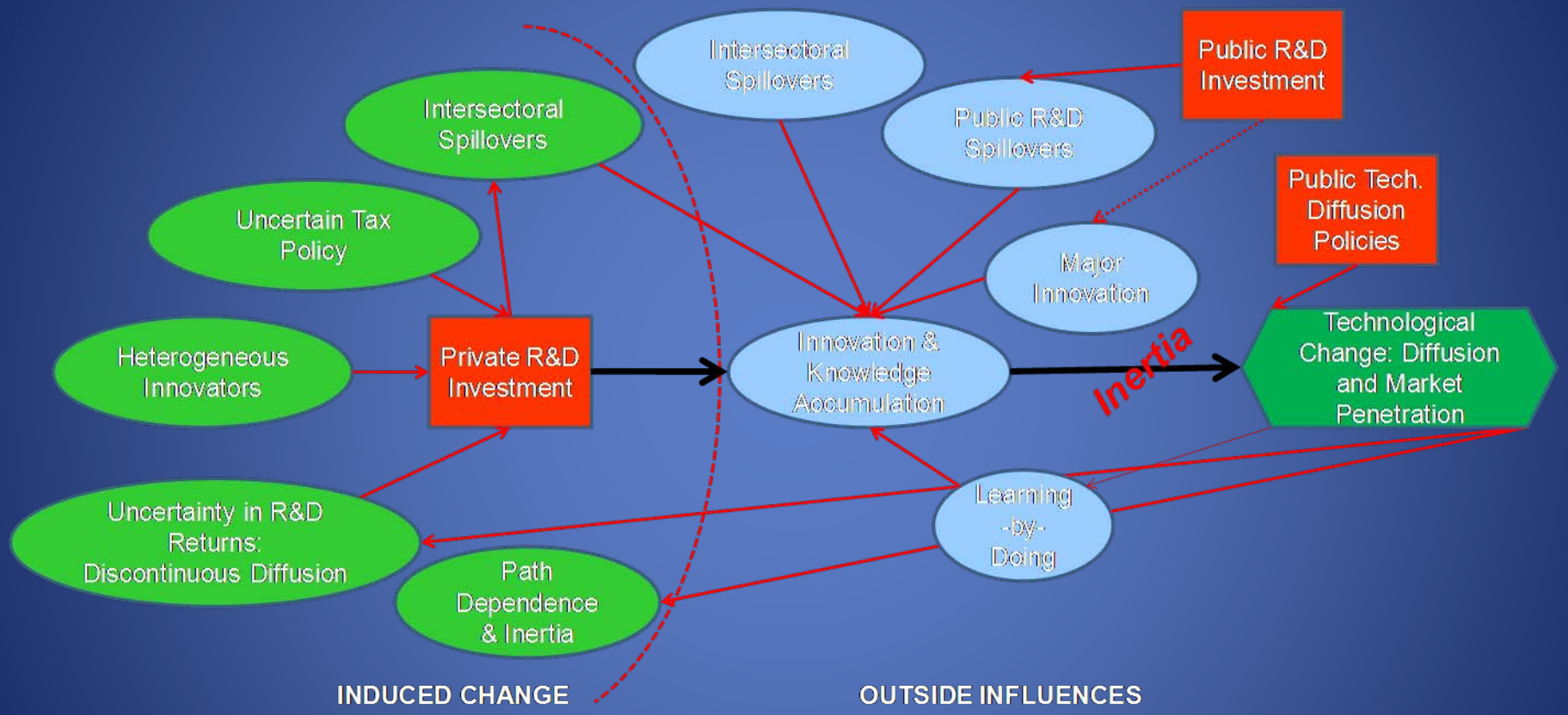
Understanding / Modeling Technological Change



Weyant, J.P., "*Energy R&D for Innovation*" , IPIECA Workshop: Increasing Pace of Technology Innovation and Application: Enabling Climate Change Solutions, Washington, D.C. 2006.

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Improving the Odds and Embracing Failure

The scientific , technical and engineering arena

- ***Fail early – fail often***
- ***Focus on fundamentals***
- ***Expand experimentation with modeling***

The organizational arena

- ***The "Six Levers of Innovation"***
- ***Engage leadership without regard to position***
- ***Provide education, experience and culture***

The market arena

- ***Modeling***
- ***Use strategic networking and partnering***

The policy arena

- ***Modeling***
- ***The "Six Levers of Innovation"***

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Policy Focus

- **Constancy of Purpose in Technology Programs**
- **Upgrading the Adequacy of the Science Base**
- **Using Broad / Multiple Approaches**
- **Adhering to Aggressive Development Goals**
- **Increasing Focus vs. Spreading Thin in Business Extensions**
- **Achieving Business / Technology Interspersing**

Make Policies, Their Application and The Results Transparent and Broadly Available

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In Memory of
Nathaniel J. Mass

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