Purpose of Paper

- Review reasons for trying to accelerate transformational change
- Summarize these alternative views of how to make transformational change happen,
- Consider what we know about targeted government funding of R&D as a way to induce transformational change

Precourt Energy Efficiency Center

Reasons for trying to accelerate transformational change

- Climate change is emerging faster
- Incremental changes in energy technologies are not enough to avoid disruptive climate change
- Future climate largely determined by emissions between now and 2030
- So transformational changes in energy technologies are needed very quickly

- Translation: Marginal value of creating technologies to reduce greenhouse gases is very high, higher than we thought even a few years ago

Precourt Energy Efficiency Center

Alternative views of how to make transformational change happen

- Clearly, economic incentives are not without value:
  - Market incentives are a key to *incremental* technological change
  - Economic crises can be a trigger for creative thinking
  - Corporate R&D laboratories have produced technological breakthroughs in such fields as IT and pharmaceuticals

Alternative views of how to make transformational change happen

- Serendipity
  - o Discovery usually occurs by accident, not by design
- Long-term historical forces
  - o Technological breakthroughs are subject to historical cycles of innovation “(Kondratiev waves” of 50-60 years in length)
- The diffusion of knowledge

- Prizes

Precourt Energy Efficiency Center

I would Like to See in Paper: Supply and Demand for Innovation

- There is a supply and demand for innovation, even potentially transformative innovation
- Supply
  - Basic thinking skills -- education
  - Creativity
  - Information
  - Resources to facilitate research
- Demand
  - Is there a value to the innovation?
  - What value can the innovator capture?
    - Value can be monetary, prestige, power

Precourt Energy Efficiency Center

- Serendipity
  - What people are thinking about is unlikely to be pure accident. Thus can be influenced by policy. Supply and demand can be changed.
- Long-term historical forces
  - Policy cannot do much about waves
- The diffusion of knowledge
  - Policy can make a large difference. Culture matters. Supply side of innovation. Possibly demand side

---

- Prizes
  - Prizes are offered to accomplish end(s). Demand side of innovation. Stochastic rewards.

Targeted Government Funding of Transformational R&D

- “Manhattan Project”
- ARPA-E

Precourt Energy Efficiency Center

I Would Like to See in Paper

	Prizes	Manhattan Project	ARPA - E	NSF-Type Funding	Support Education
Serendipity	No	No	Maybe	Maybe	Yes
Waves	No	No	No	No	No
Knowledge Diffusion	Probably Not	No	Possibly	Maybe	Yes
Economic Motivation (Including Prestige)	Yes (Demand)	Yes ?? (Demand, Supply)	Yes (Supply)	Yes (Supply)	Yes (Supply, Demand)

Entrepreneurship:

- In United States, most company founders are experienced, well-educated and married with children -- and they come from middle-class or upper-lower-class backgrounds.

- From *The Anatomy of an Entrepreneur*, Ewing Marion Kauffman Foundation