Getting Value From Research:

From Research Knowledge to Profitable Products

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What You Will Learn From This Talk

- *Point of View:* The pursuit of industrial research is fundamentally different in 2004 than in the 1970's – 1990's because the global geopolitical environment has changed. This difference affects every emerging physics PhD and the policies that APS must pursue to maintain a vital contact with physics in industry.
- In this presentation I indicate how the competitive environment has changed, why and how industrial research has changed in response, and what this means to physicists who elect to pursue a career in industry.

Agenda

- Why firms perform R&D
- One size does not fit all: The technology-market matrix
- The creation of (economic) value: Options, value chains and business models
- The evolving geopolitical environment changes
  - The context of R&D
  - The innovation paradigm
- Impact on industrial research, physicists employed in industry, and the APS

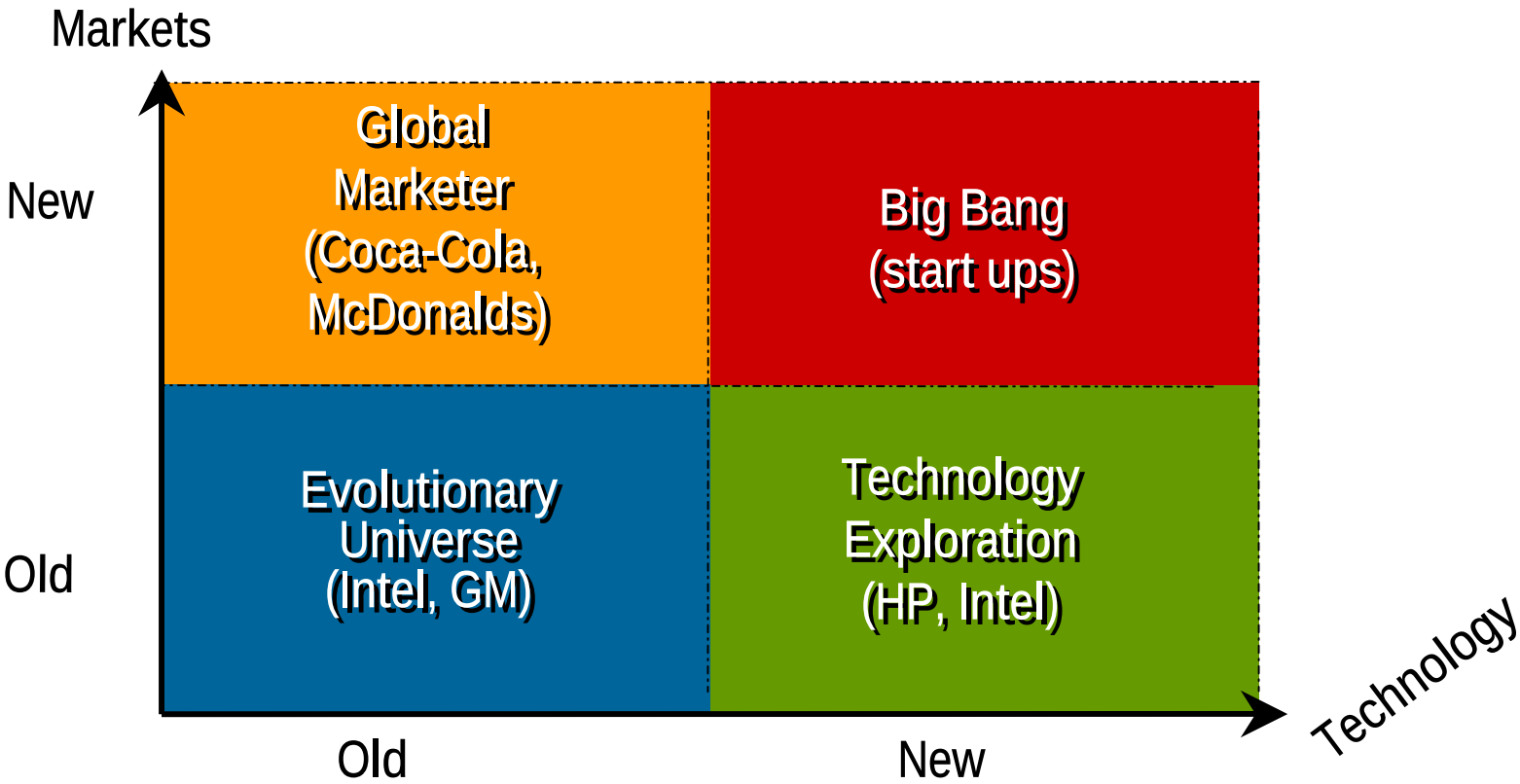
Why Do Firms Perform R&D?

- To grow – Through new products and services to new markets
- To survive – The onslaught of competitive product performance improvements and pricing cuts in currently served markets
- Research and development are *very* different
  - Research: New concepts for growth
  - Development: Technology injection into base product lines for survival

Small R Versus Big D

- Research
  - Creates future investment options
  - Emphasizes discovery
  - Outcomes cannot be predicted or scheduled reliably
  - Managed for creativity
- Development
  - Creates product designs and prototypes
  - Emphasizes performance at cost
  - Outcomes expected to be predictable and delivered on schedule
  - Managed to minimize risk to cost and schedule
  - Development $ ~10X Research $

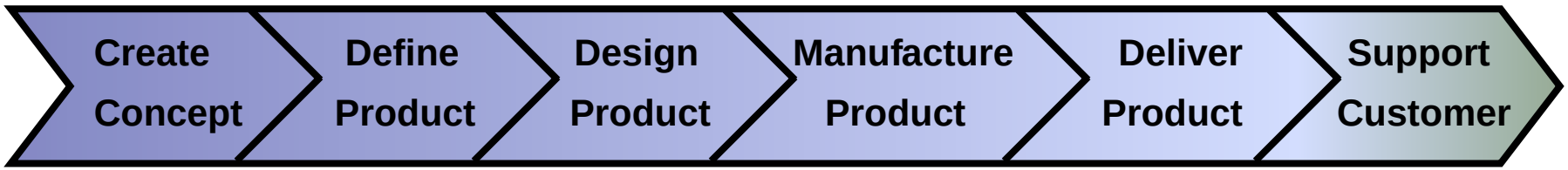
One Size Does Not Fit All



- A firm must both protect its current businesses (evolutionary universe) and grow (one of the other three quadrants).

The Creation of Value

- Research creates investment options for further investment to develop products or services that enable growth. [e.g., F. Peter Boer, *The Valuation of Technology*, (Wiley, 1999)]
- To create value, these options must be exercised all the way down a complete value chain.



- "A chain is only as strong as its weakest link".

It's The Business Model, Stupid

A business model

- Describes how a firm will make money
- Links technical inputs to economic outputs
- Converts intellectual property into economic value

Note: Knowledge is converted into potential economic value via intellectual property, but most intellectual property is worthless because it is not embedded in a viable business model to convert it into realized economic value.

The World is Changing, Profoundly

- Creation of a global economy: International outsourcing and pricing
  - Globally available, mobile technical manpower
  - Plentiful technical knowledge
  - Inexpensive, instantaneous global communications
  - Accessible venture capital
- End of the cold war – rise of the war on terror
- From military to economic competition: Peace through prosperity

Changing The Context of R&D

- Industry structures change from vertical to horizontal (PCs, consumer electronics, autos, ...)
- intellectual property (e.g., patents) and sources thereof explode (universities, national labs, small and large firms, consultants,....)
- Manufactured products become complex systems (airplanes, autos, consumer electronics,…) built from standardized components
- Manufacturing industries consolidate around dominant, often modular, designs and a few large suppliers (e.g. PC's – Dell, HP, IBM which source components from common suppliers, often in the far east)

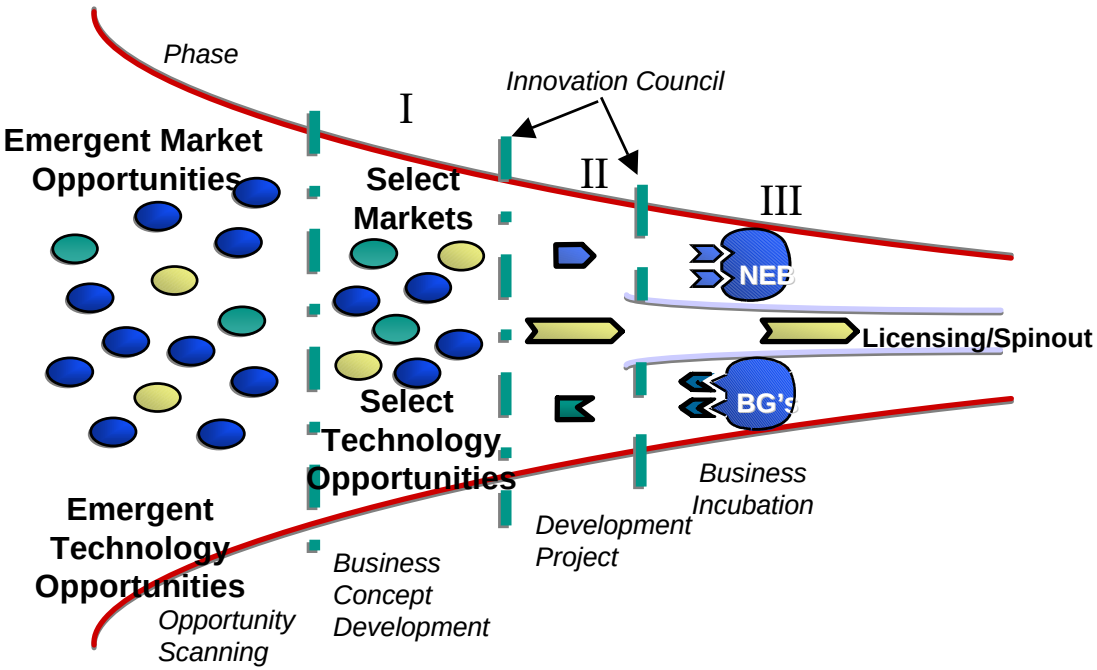
And Changing The Innovation Paradigm

- From “closed” (vertically integrated) value chains in which all elements are in the same firm
  - Traditional model: GE, IBM, Bell Labs, Xerox, Dupont in the 1960s-1980s
  - Assumes scarce knowledge, limited mobility of technical talent
- To “open” (horizontal supplier structure) value chains in which different firms deliver different elements in the value chain
  - New model: Intel, IBM, Lucent New Ventures Group
  - Assumes plentiful knowledge, mobile technical talent, ready availability of venture capital

Reference: ***Henry W. Chesbrough, Open Innovation: The New Imperative for Creating and Profiting From Technology*** **(Harvard Business School Press, 2003)**

The Technology Pipeline

- Technology is developed into product via staged phase gate process:



- In a closed innovation paradigm projects flow down the pipeline from within the firm. Technology development is vertically integrated with product development.
- In an open innovation paradigm, knowledge, technology, components or subsystems can enter the pipeline from outside the firm. Similarly, these entities can exit the pipeline to be further developed by other firms for their products.

Implications for Industrial Research

- New products increasingly involve the integration of knowledge and intellectual property from different firms.
- Firms want to control product design – often outsource manufacturing and even service.
- Management and control of the value chain is the critical path. Research is just one input.
- As designs of manufactured products increasingly depend on the integration of standard components, physical science research at the component level becomes concentrated in a small number of dominant suppliers.

Implications for Physical Scientists

- Most physical science jobs in industry are in development, not research.
- Research in industry increasingly concentrates on conceiving and designing new products and/or new value chains, rather than on new phenomena. The “Bell Labs” era of basic research in industry has morphed into the “Intel” era of university-industry collaborations.
- Technology is not “transferred”, it is incorporated *a priori* into new product definition and design by cross functional teams.
- The primary role of physical scientists in industrial research is that of a subject matter expert solving problems as members of cross-functional definition or design teams. The employers of these scientists can be firms, universities, or consulting houses.
- Ownership of individual items of intellectual property (e.g., patents) is less important than the ability to incorporate such items into complete value chains. The high-value competence is the ability to integrate intellectual property from different sources into products that source components (or even assembly and service) from globally dispersed suppliers.

Implications for the APS

- Industrial research in the physical sciences has changed from knowledge creation to option creation -- with implications for APS meetings and publications.
- Industrial research has become dispersed: Many small players are replacing a few dominant players– with implications on the delivery of physics content to industry and physicists' careers in industry.
- All R&D has become global: The "A" in APS should really be "I" (for International)– and all that this implies.
- The boundaries between "basic" and "applied" and between "science" and "technology" are becoming blurred, with implications for APS governance, meetings and publications.
- Physics has a great future, but it will be different in kind from its past. Will APS be a leader or a Luddite?

Synopsis

- The environment for industrial R&D has changed profoundly during the past fifteen years.
  - From national to global markets and firms
  - From vertical to horizontal industry structures
  - From limited to plentiful knowledge and technical talent
  - From difficult to easy access to venture capital
- These changes stimulated a transformation of the dominant innovation paradigm from “closed” to “open”.
- As part of this transformation, the era of basic physical science research in industry is over. Modern industrial research creates new investment options, not new knowledge *per se.*
- Consequently, physicists working in manufacturing industries can expect to be subject matter experts working on cross functional teams to design new products or processes. University partners may be members of that team.