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**Fred Pries**

**Abstract**

**Presentation**

# The Changing World of Industrial Innovation

Fred Pries

*Institute for Innovation Research, University of Waterloo*

Not all inventions become innovations. Invention involves the creation or discovery of a new technology while innovation involves putting the new technology into use either by introducing a new product to the market (product innovation) or by using it within a production process (process innovation). The paths from invention to innovation are risky and often lengthy processes with only a small percentage of inventions actually being put into use. For example, Sonora, a polymer platform developed by DuPont, took 60 years from initial discovery to product introduction. The ‘struggle for life’ of inventions to become innovations involves adaptation and change to overcome technical risks and market uncertainty.

The paths from invention to innovation are changing. In the ‘old world’ of closed innovation, all of the activities from initial research through technology development, product development and product launch took place within a single firm. This was the innovation process used by DuPont in the discovery and commercial production of nylon. While this ‘old world’ of innovation continues to exist, a ‘new world’ of open innovation is emerging. In the world of open innovation, inventions made by one organization are often commercialized by other organizations. The commercialization of the UNIPOL polyethylene gas phase process and metallocene catalyst technologies is an example of this world of open innovation.

As a result of these changes, more options for commercializing new technologies are becoming viable. Specifically, inventors of new technologies have opportunities to 1) Build – create a new business based on the technology, 2) Rent – ongoing development and marketing of the technology to established firms that use the technology in their businesses and 3) Sell – dispose of the technology to an established firm.

The world of innovation is changing. The simple linear process of research, development, product development and launch by a single firm no longer reflects how innovation happens. In this changing world, ideas come from many sources and many different options to commercialize exist.



# The Changing World of Industrial Innovation

Fred Pries  
University of Waterloo  
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# What is innovation?

- Invention – discovery of a new technology
- Innovation – “Technological product and process (TPP) innovations comprise *implemented* technologically new products and processes and significant technological improvements in products and processes. A TPP innovation has been implemented if it has been *introduced on the market* (product innovation) or *used within a production process* (process innovation).” OECD, Oslo Manual, January 1996

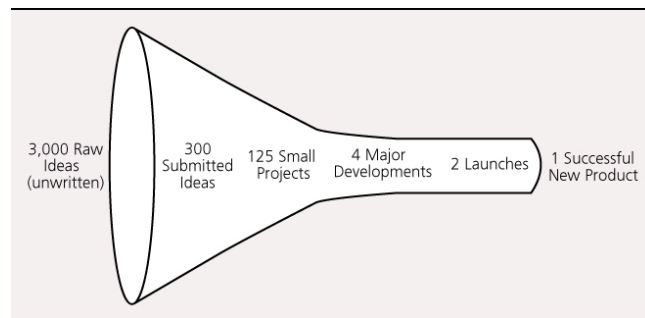


# Sonora™

- Polymer platform developed by DuPont
- Early 1940s – product *invention* but cost-prohibitive to produce
- Mid 1990s – process *invention* enables cost-effective production
- Early 2000s – product availability – *innovation*
- 60 years from invention to innovation
- Major technological advances typically:
  - Require a cluster of inventions (as many as 12)
  - Take 20 years from first invention to implementation
  - Citrus fruit to cure scurvy – 200 years (Rogers, 2003)



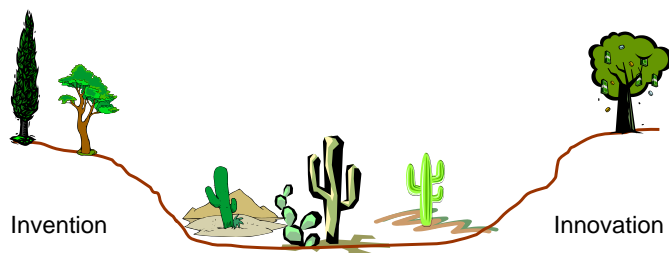
# Innovation is risky



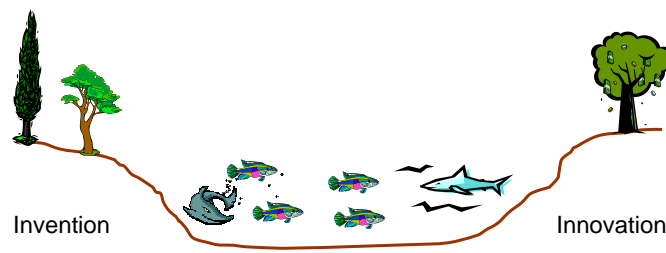
Stevens & Burley, 1997



# The Valley of Death



# The Darwinian Sea



“The ‘Struggle for Life’ is a sea of technical and entrepreneurship risk”

Branscomb, 2004





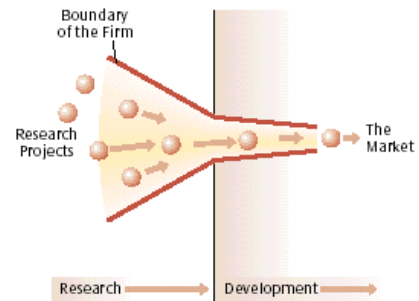
## What drives innovation?

Product innovation	Replace products being phased out	3.1
	Extend product range within main product field	3.8
Product diversification	Extend product range outside main product field	2.7
Extension of local market	Increasing or maintaining market share	4.2
	Creating new markets nationally	3.4
Opening up of global markets	Creating new markets within the European Community	3.3
	Creating new markets in North America	2.0
	Creating new markets in Japan	1.7
	Creating new markets in other countries	2.3
Process innovation	Improve production flexibility	3.5
	Reducing the share of wage costs	3.4
	Reducing materials consumption	3.2
	Reducing energy consumption	2.9
	Reducing product design costs	2.3
	Reducing production lead times	3.5
	Reducing environmental damage	3.3
	Improving product quality	4.0
	Improving working conditions/safety	3.5

**IR** Source: Innovation in the European Chemical Industry, 1996



## The 'old world' – closed innovation



Chesbrough, 2003

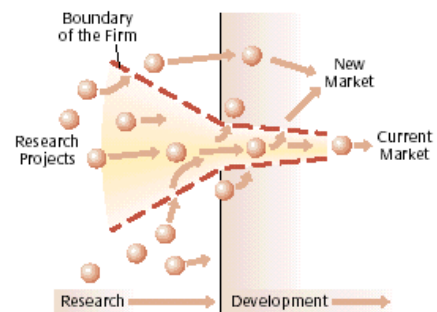


## DuPont's discovery of nylon

- 1927 – DuPont sets up a fundamental research program
- 1930's – Research by Dr. Carothers and colleagues results in invention of nylon
- 1939 – DuPont begins commercial production of nylon
- Entire process in-house



## The 'new world' – open innovation



Chesbrough, 2003



## What is driving the transition

- Increasing availability and mobility of skilled workers
- Increasing availability of venture capital
- Emergence of external options – markets for technology
- Increasing capability of suppliers

(Chesbrough, 2003)



## Univation Technologies

- UNIPOL polyethylene gas phase process – Union Carbide
- Metallocene catalyst technology – Exxon
- Univation
  - 50/50 joint venture to license the technologies
  - World's #1 licensor of PE technology with >90 reactors around the world





## Sources of information for innovation

Internal sources	Internal sources within the enterprise	3.6
	Internal sources within the group of enterprises	1.9
	Patent disclosures	2.3
Science	Consultancy firms	2.0
	Universities/higher education	2.0
	Government laboratories	1.8
	Technical institutes	1.8
Other firms	Suppliers of materials and components	2.9
	Suppliers of equipment	2.9
	Clients or customers	3.4
	Competitors	2.9
	Professional conferences, meetings, journals	2.9
	Fairs/exhibitions	2.7

Source: Innovation in the European Chemical Industry, 1996



## Build, rent & sell

- Open innovation allows different paths to commercialization – beyond ‘use’
- Three primary methods
  - Build – creating a new business based on the technology
  - Rent – ongoing development and marketing of the technology to firms that use the technology in their businesses
  - Sell – disposition of the technology to an established firm



## Build

- Creating a new business based on the innovation
- ‘Product market’
- New technology is source of competitive advantage
- New firm acquires or develops the complementary assets (e.g., manufacturing capabilities, distribution networks) needed to commercialize the innovation



Examples: Dalsa, OpenText, Waterloo Barriers, Certicom



## Rent

- Ongoing development and marketing of the innovation to established firms that use the innovation in their businesses
- ‘Market for ideas’
- Inventor/university retains ownership of the innovation and continues to grow and harvest the innovation
- Often ‘rented’ to more than one established firm



Examples: Senesco, Waterloo Emitters™ Handshake VR, Ignis Innovation



## Sell

- Disposition of the innovation to an established firm
- Established firm typically has the complementary assets needed to commercialize the innovation
- Future enhancements typically undertaken by acquiring firm
- Examples: Solid phase microextraction (SPME) to Sigma-Aldrich Corporation, many biotechnology and software start-ups



## Summary

- A changing world of innovation
- Simple linear process no longer reflects how innovation happens
- Ideas come from many sources
- Multiple options to commercialize exist
- Crossing the Darwinian Sea
  - “It’s a sea full of sharks, and it’s full of little fishes. There’s all kinds of stuff happening. If you think about how you get from the research world to the innovation world, it turns out there are lots of pathways. And they’re complicated. ... It is the vibrancy of this connection that is necessary to make it possible to go from one culture to a radically different culture successfully.” (Branscomb, 2004)





## So what?

- Corporations
  - Look outside for sources of innovation – NIH syndrome
  - Look outside for opportunities to commercialize – Rembrandt's in the attic
- Academic researchers and independent inventors
  - Numerous options exist – build, rent & sell
  - Choice may affect likelihood of success



## Questions?

