BP Centennial public lecture

Practice Makes Progress: the multiple logics of continuing innovation

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Suggested hashtag for Twitter users: **#LSEWinter**

Overview: This lecture includes

One key contrast: “ideas” versus “logics”

Three examples of “logics” of innovation

Brief comments on related discussions in economics, management and policy

Concluding remarks

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I. Drivers of Innovation:

Ideas, inventions and logics

Got the next big technology idea?
Here's your chance to showcase it...

Deloitte Top Technology Talent Competition
Business plan

Name (Group lead/individual entry)	
University	
Degree course	
Year of graduation	
Email address	
Mobile number	
How did you hear about the competition?	

Group members:

Name	Degree course	Year of graduation

They say you can't patent an idea: Test that one in your search engine!

How to Patent an **Idea**: 10 Steps (with Pictures) - wikiHow
www.wikihow.com › ... ›

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Joseph A. Schumpeter, 1883-1950

Schumpeter made a sharp, then-*novel* conceptual distinction between *invention* (which of course was long familiar and celebrated in its own right) and *innovation*.

In Schumpeter's early work (TED), development is the result of innovations by entrepreneurs, disrupting the equilibrium "circular flow." He seems to have had large-scale innovations mainly in mind.

I. *The Theory of Economic Development*, 1911 [1934]
II. *Capitalism, Socialism and Democracy*, 3rd ed, 1950

Inventions (or "ideas"?) vs. Innovation per JAS

- "As long as they are not carried into practice, inventions are economically irrelevant. And to carry any improvement into effect is a task entirely different from the invention of it and a task, moreover, requiring entirely different kinds of aptitudes."
- There is no real shortage of "… new possibilities. They are always present, abundantly accumulated by all sorts of people" (TED, p. 88)
- the entrepreneurial function "does not consist essentially in either inventing anything or otherwise creating the conditions which the enterprise exploits. It consists in getting things done." (CSD, p. 132).

This “idea” idea underemphasizes several things

- The importance of persistence and hard work.

"Genius is one percent inspiration and ninety-nine per cent perspiration. Accordingly, a 'genius' is often merely a talented person who has done all of his or her homework.” --- Thomas A. Edison (in various versions & places)

- The extended, cumulative and highly social nature of progress in particular fields (e.g., understanding of electricity).
- The role of many contextual and organizational factors (e.g., cooperation and competition, networks, challenges).
- THE SUBSTANTIAL BODIES OF KNOWLEDGE THAT POINT OUT PLAUSIBLE PATHS TO PROGESS (but do not describe the detailed implementation)

Diverse terminology in a multi-disciplinary literature

- What are here called “logics” are close cousins of familiar concepts that have been introduced and studied under other names, including “natural trajectories,” “technological paradigms,” “technological trajectories.” More general terms, such as “heuristics” and “principles” are also appropriately invoked.
- Contributions to conceptual understanding and detailed case studies have been advanced by scholars from many fields, including economics, sociology, economic history, business history, technological history, and management.

II. Three Illustrative "Logics"

Increasing the size of equipment units

***D*ecreasing the size of design features (miniaturization)**

Spatial replication

(more of about the same, only elsewhere)

The "multiple logics"

- Are diverse as well as numerous.
- Often have a "fractcal structure" (narrow rules/heuristics are nested in broader ones).
- Some have a solid foundation basis in "STEM" knowledge, others not so much.
- Many are, at this point, long- familiar paths to innovation.
- None offer a guarantee of innovative success, much less a specific success achievable within given time and budget constraints.
- ALL HAVE SHAPED THE WORLD WE LIVE IN, AND ARE RESHAPING IT RIGHT NOW.

Miraculous Logics?

- None of these high-level logics describes an actual way to achieve anything in particular – they are not recipes, or algorithms, or points in production sets.
- If they were, perhaps there would be no need for "practice."
- In each case, innovative success with a "logic" depends on solving a host of problems that are associated with the actual physical materials, people and locations involved. Repeated engagement with these relaxes the constraints over time.
- Is the high-level logic a significant factor compared to the innumerable low-level problem solutions?

Example 1: Scaling up equipment: From geometry to cost

- **Increasing the linear scale of a 3-D object, while maintaining its geometric configuration, increases the surface area according to the square of the linear dimension and the volume according to the cube.**
- **If the object is a unit of productive equipment of some sort, the question is how the different dimensions relate to cost and to output.**
- **A quite common case is that capacity is closely related to volume while cost is closely related to surface area. In the ideal case, capacity cost per unit then varies as the two-thirds power of capacity.**

From the DC 3 to the A 380

Length ratio = 3.7. (note: 3.7 squared = 13.7)

Passengers ratio: about 20 to 30, depending on configuration

Years between first flights: 70

Example 2: Miniaturization in semiconductors: Gordon Moore's (top-level) Innovation Logic

"By making things smaller, everything gets better simultaneously. There is little need for trade-offs. The speed of our products goes up, the power consumption goes down, system reliability, as we put more of the system on a chip, improves by leaps and bounds, but especially the cost of doing things electronically drops as a result of the technology."

-- Gordon Moore, "Lithography and the Future of Moore's Law," 1995 SPIE speech, final page (Intel)

From description to prediction to strategy

- **Gordon Moore *observed*, in 1965, that the number of transistors on a chip had been doubling annually for a few years (starting from the planar transistor in 1959).**
- **He *predicted* that this pace would continue for at least ten years, and estimated that in the future the doubling time would be two years.**
- **"Intel, which has maintained this pace for decades, uses this golden rule as both a guiding principle and a springboard for technological advancement, driving the expansion of functions on a chip at a lower cost per function and lower power per transistor by introducing and using new materials and transistor structures." -- Intel's website today**

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Challenges along the way

Wafer size, purity of the silicon

Yield issues, especially as chip areas and component numbers increased.

Manufacturing environment: Clean room technology.

Multiple challenges of photolithography technique: Shrinking feature size, declining wave lengths of the light. Generations of Innovation in lithography equipment

Example 3: Replication

- Replicator organizations are firms whose growth strategy is based on the idea of creating, in an expanding set of new locations, new units that function according to the same routines that are followed in other locations by the existing units.

- Such firms are particularly common (and highly visible) in retail settings, such as fast food, restaurants, hotels, banks, brokers, coffee shops, office supplies, home improvements, book stores, low-priced furniture, and clothing shops.

Challenges for replicators

- Replication would pose little challenge to replicators, and perhaps little to managers involved, if physical space were homogeneous.
- In fact it is heterogeneous for physical reasons (e.g., weather) as well as for economic, cultural and institutional ones.
- Site selection, knowledge transfer, and attention to the possibilities and hazards of adaptation are key challenges, largely for managers at HQ.

III. Related discussions

Economics

(production theory, evolution)

Strategic Management

(sustainable advantage, dynamic capability)

Policy

(the “innovation system”)

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"Towards an evolutionary theory of production"

- Economists remain quite attached to the theoretical idea that economic actors generally get the right answers to their decision problems. Actors know what *could* be done and decide what *should* be done.

- In the processes of technological change, the comparison of the alternatives is deeply intertwined with the discovery of the alternatives, which is a sequential "path-dependent" process.

- It is quite possible model such processes in ways that respect the micro-level realities. It is very hard to do that and respect the "right answers" commitment as well.

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Schumpeter on the routinization of innovation

"Progress itself may be mechanized as well as the management of a stationary economy, and this mechanization of progress may affect entrepreneurship and capitalist development nearly as much as the cessation of economic progress would." (CSD, 3rd ed. (1950) p. 131).

"… it is much easier now than it has been in the past to do things that lie outside familiar routine – innovation itself is being reduced to routine. Technological progress is increasingly becoming the business of teams of trained specialists who turn out what is required and make it work in predictable ways…. (p. 132)

Teece, et al., on "dynamic capability"

D. Teece, G. Pisano and A. Shuen, "Dynamic Capabilities and Strategic Management" *Strategic Management Journal* 18 (1997), 509-533.

- **Per these authors, "dynamic capability" confers upon a firm the ability to cope with change – where successful "coping" involves in particular the maintenance of high profitability.**
- **Can the ability to cope with change be improved through practice?**

The U.S. Innovation System:
The Magic in the (Accidental) Mix

- **The "ideas" path to progress and the "logics" path have been strongly complementary in the U.S. in recent decades.**

- **Nobody designed the system to function this way; the "logics" part was put in place for other reasons – to wage expensive "battles against cancer and Communism." (Keith Pavitt's characterization of U.S. "industrial policy.")**

- **In principle, a better system could be designed. But in practice?**

IV. Concluding comments

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