

6. Markets

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While much of this conference was driven by a technology-push vision of the future, in which technical possibilities are used to forecast future developments, this group focused on economical and social factors that may serve to either constrain those possibilities or to shape them through demand-pull.

Technologists often underestimate how much of supposedly technical trends are actually driven by market or other social forces. An example of this is provided by so-called Moore's Law. While this law is often depicted as the result of physical principles and engineering innovation, much of its character is determined by economics. Thus, delivered CPU chip speeds have increased over the last 2-3 years at a pace that exceeds Moore's Law. Various technical explanations for this have been offered, but the real reason is economic: Intel has always kept a 2-3 year technology backlog, which is taken to market at a rate designed to maximize profitability. This was possible because of their dominant market position. However, three years ago, AMD and Cyrix mounted a significant challenge to Intel's market dominance with new products that quickly captured 25% of the market, resulting in a 50% drop in Intel's stock price. Intel responded to this challenge by bringing technology to market faster than had been its historical practice, successfully meeting the challenge posed by AMD and Cyrix, and as a side effect, beating the rate of increase predicted by Moore's Law.

We are experiencing a major economic cycle in the adoption of widespread information technology analogous to earlier economic transformations such as the industrial revolution. The early stages of such cycles are dominated by the introduction of revolutionary products and services, but the latter stages involve the creation of standardized infrastructures and institutions. Thus, while the events in the early stages of such a transformation may be partially foreseen by thinking through the technological requirements and opportunities,

in the latter stages very competitive technologies may fail due to the lock-in effects of infrastructure created around previously deployed technology. The information revolution may at this time be approximately in mid-cycle. This suggests that while in the past some vision of the future may have been available by thinking about technology, increasingly the future will be determined by markets, standards, and social forces.

Market Criteria

It may be useful, for example, to move from thinking about “what” people want, to “how” they want it. Thus, some important market criteria that can determine the widespread adoption of an artifact or technology are:

- ease of use
- backward compatibility
- enjoyment from use
- low or no cost of ownership
- affordability
- non-critical failures.

Various geographic regions and market segments may vary in their requirements. Important criteria include levels of income (where affordability and cost of ownership may be much more important in emerging economies), extent to which societies or segments are market driven, and the regulatory environment, as the amount of government intervention varies enormously among countries and among segments within a country.

This breakout group envisioned that to determine likely futures, one must take the list of possible or desirable futures being generated by the rest of the workshop and subject them to a screening for market feasibility. Four general classes of filter were discussed:

- whether there is needed supporting infrastructure
- whether there is market demand (or acceptance)
- whether funds adequate for development are likely to be provided
- whether the necessary manpower or talent is available (very critical in developing countries).

Supporting infrastructure needed for product viability includes:

- electrical power
- telephone or other communications
- payment schemes
- protocols and standards
- distribution channels or mechanisms.

Drivers of market demand are:

- ease of use
- affordability
- creation of economic value
- entertainment
- creates knowledge or information
- additional regional criteria (in particular governmental policy or cultural social values).

Funding availability is driven by:

- a clear business proposition
- availability of a robust capital market
- government policy
- intellectual property protection
- venture capital culture
- feasibility of collaborative efforts.

Availability of needed manpower or talent is a function of:

- proper incentives
- education
- immigration policy
- educator availability.

All of the above must be addressed to create a likely future. As mentioned above, they might be thought of as “filters” through which an invention or innovation must pass to be truly successful in having an impact on a society.

Regional Market Drivers and Limiters

Various of such factors may play varying roles as market criteria in differing regions of the world. The group wrote the following chart as *examples* of market criteria by region, although this is certainly not based on any serious analysis. The intent of this chart (Table 6.1) is as an illustration of the analysis that might be performed by regional and technology experts working together.

Table 6.1: Examples of Possible Regional Market Drivers and Limiters

	Drivers	Limiters
North America	time savings improves health	backward compatibility
Europe	educational value time savings improves health	social concerns; backward compatibility
North Asia	fashion, image educational value	government policy; backward compatibility
Mideast		social concerns
South(East) Asia	creates expertise empowerment educational value	lack of capital, infrastructure, and human expertise
Africa	creates expertise empowerment fulfills basic life needs	lack of capital, infrastructure, and human expertise
Latin America	creates expertise	lack of capital, infrastructure, and human expertise

Technology Life Cycle

There are separate markets for the invention of new technologies and the innovation of new products based on an existing technology. Either of these markets can be strong or weak. The relative state of these two markets dictate where you are in a cycle of innovation, as shown in Fig. 6.1.

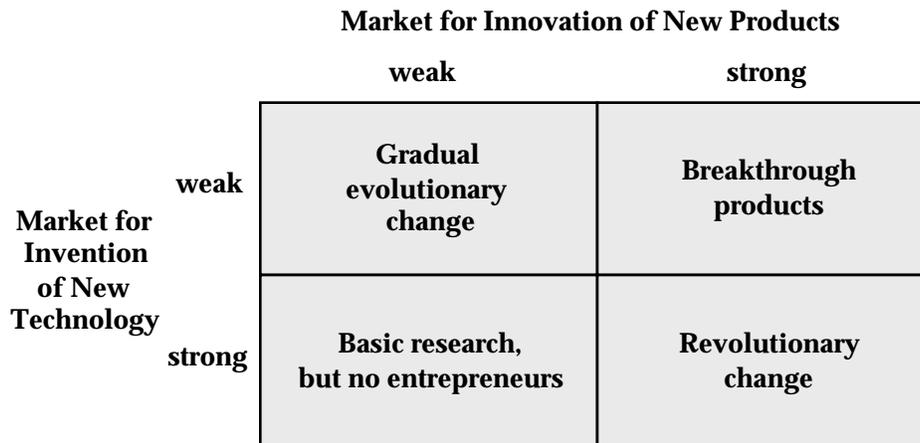


Figure 6.1 – Developments Depend on Separate Markets for Invention and Innovation

A technology life cycle begins in the lower left quadrant, where the market for invention of new technology is strong but the market for innovation of products is weak. This is the normal state of affairs when a technology is immature and not ready for productization. However, if the culture has a shortage of entrepreneurs, a cycle of technology development could be stalled there. If a technology shows promise, the next stage would be the lower right quadrant, where the market for both invention and innovation is strong, and in this part of the life cycle, revolutionary changes can occur. Later, as the technology matures, the market for invention can weaken, and while breakthrough products may still be produced, the infrastructure for this technology is consolidating, and the potential for truly revolutionary change is diminishing. Last in a technology life cycle, we arrive at the upper left quadrant, where the market for both innovation and invention becomes weak, and only evolutionary change is permitted.

The diagram in Fig. 6.1 invoked stimulated discussion. The notion of some group members was that basic R&D comes from Ph.Ds rather than from corporate ranks – i.e., that there was a pipeline from the universities to corporations. In the discussion, it was pointed out by other participants that few basic inventions in IT came from universities. That is, “the pipeline doesn’t start at the universities,” as one participant put it. It was mentioned that the “Brooks/Sutherland report” (CSTB, 1995) documents several key technologies

and discusses how initiatives shifted back and forth between the “university” and the “corporation.”

Invention of new technologies and innovation of new products are frequently confused, but it is important to distinguish them, as they have different characteristics, and must be promoted in very different ways.

Ken Arrow and others (Alchian, 1958) did a classic analysis of the shortage of engineers and scientists after Sputnik that perhaps needs to be updated to analyze the current set of challenges. (One participant mentioned that recent work by Romer may be relevant in exploring this topic.)

During the plenary discussion that followed this breakout group’s report, a participant drew the following figure, linking innovation and invention in a continuing interplay of “cycles.”

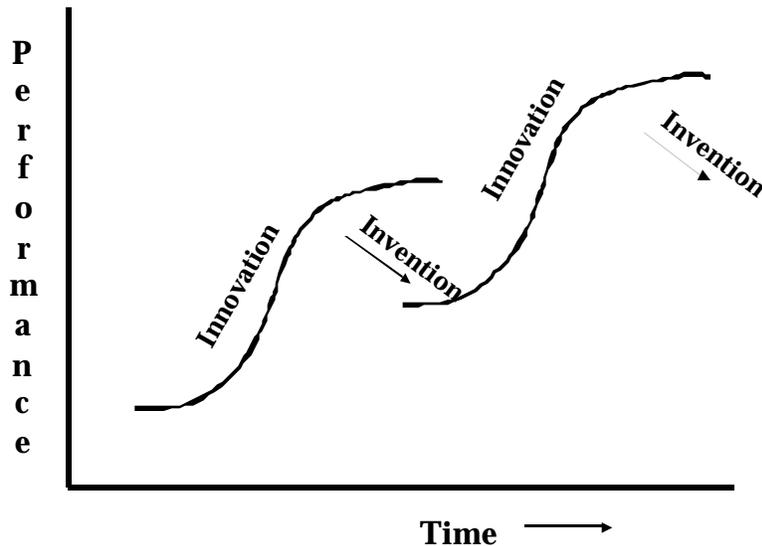


Figure 6.2 - The Interplay of Innovation and Invention Over Time

It might be a useful exercise to elaborate on this diagram for some key IT developments (e.g., wireless communication, wearable computers, \$1 ubiquitous sensors) to see what the time cycles might be and how various innovations stimulate the next cycle of invention and innovation.