

## The Advent of the Technology Portfolio/Boris Petrov

Technology can have a substantial impact on a business in three ways:

- It can change relative competitive cost positions within a particular business.
- It can create new markets and new business segments.
- It can collapse or merge previously independent businesses by reducing or eliminating their segment cost barriers.

Frequently, there is a point in the introduction of new product generations where investment in a new technology is far more productive in cost or performance improvements than further investments in the existing technology (see Exhibit 1). Both the timing and the shift from old to new technology and the magnitude of technology investments are of critical strategic importance. In fact, each of the three technologies shown in Exhibit 1 has completely changed the competitive positions among the vendors of IBM plug-compatible disk drives.

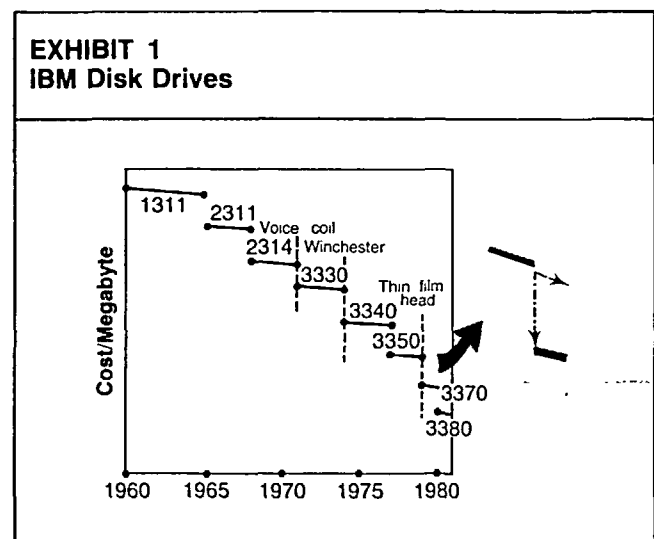
### Creating New Businesses

The introduction of a new technology frequently makes it possible to profitably serve entirely new market segments and even eventually create new businesses. Per-

haps the best recent example of this is the revolutionary impact of LSI semiconductor memories and microprocessors on a wide range of businesses. For instance, not only have comfort-control building automation systems undergone significant evolution themselves, but, in addition, an entirely new and rapidly growing small building energy management systems business has emerged (see Exhibit 2) because of cost and performance improvements (see Exhibit 3).

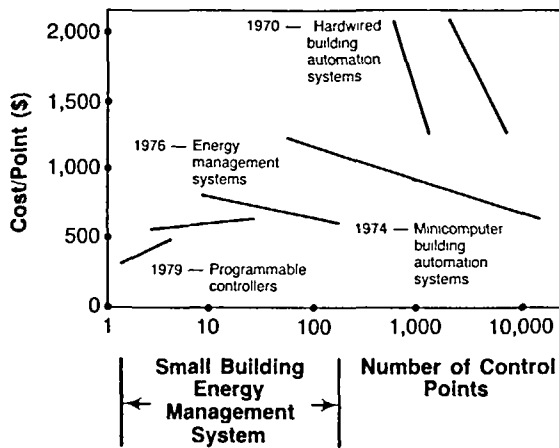
New technology frequently eliminates cost barriers among previously separate businesses. This results in

**EXHIBIT 1**  
IBM Disk Drives



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**EXHIBIT 2**  
Evolution of Building Automation Systems



three phases of such metamorphosis (discrete component assembly to LSI component manufacturing to distribution). Similarly, a single intelligent terminal business merged into a much larger business, again due to the large decrease in the cost of intelligence (see Exhibits 4 and 5).

**The Bases of Strategy Development**

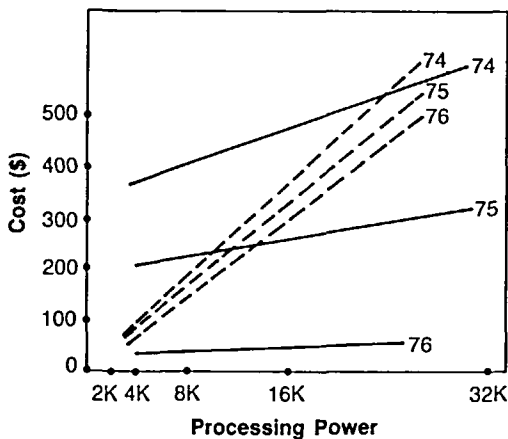
Strategy development in general is based on identifying and assessing the following:

- Major sources of competitive advantage (e.g., cost positions, market segment positions, technology positions).
- Key leverage points against which competitive advantage can be gained.

In a high-technology company, this understanding is critical because competitive dynamics can change rapidly as a result of technological innovation and superior technology management. Consequently, there is an emerging consensus that technology management is one of the responsibilities of top corporate management and corporate technology strategy is an essential element of overall corporate strategy.

Few companies, however, have established effective mechanisms for dealing with technology management responsibility, in a systematic and homogeneous manner, at the top corporate level. In practice, critical technological decisions are frequently delegated to

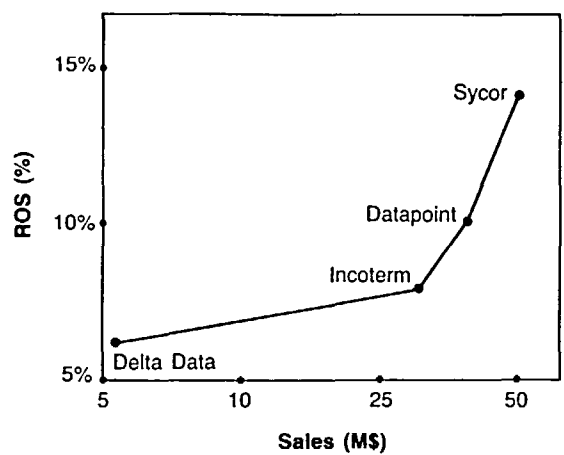
**EXHIBIT 3**  
Evolution of Processing Power Costs



**Legend:**  
 - - - "Hardwired" Logic With Memory  
 — Microprocessor With Memory

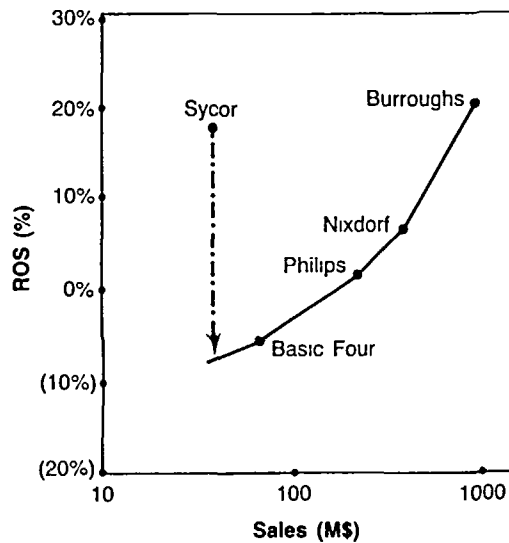
new competitive positions for former business leaders and in entirely new investment requirements for further participation in such a broadened and redefined business. Often the entire segmentation scheme changes because of the changes in the value-added and cost structure of the business. The key cost elements of the electronic watch business, for example, underwent

**EXHIBIT 4**  
Intelligent Terminal Evolution



In 1973 Sycor was a leading competitor in the single-station visual-display terminal business.

**EXHIBIT 5**  
Intelligent Terminal Evolution (Continued)



In 1976, several previously independent intelligent terminal businesses merged. Sycor's leading position in a \$200M market was replaced by a marginal position in a \$3,500M market, with an entirely new set of competitors and much larger investment requirements. The result was a dramatic decrease in Sycor's financial performance.

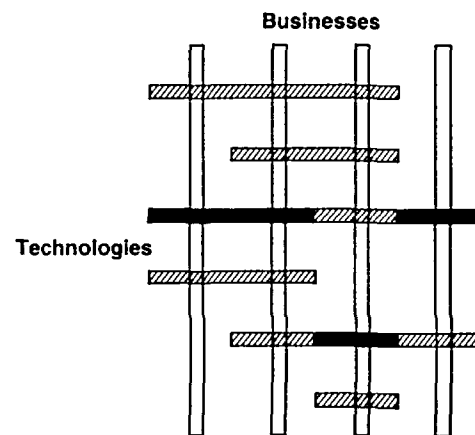
lower organizational levels or are being made without an understanding of their strategic implications.

There are several causes for the difficulties in dealing with technology management at the top corporate level. One of the most important is that a particular technology pervades many businesses and thus cannot be dealt with effectively on an individual business basis (i.e., on a fragmented basis) (see Exhibit 6). By itself, the traditional approach to corporate strategy, in which the analysis of the business portfolio provides a foundation for developing a corporate strategy, is insufficient for high-technology companies.

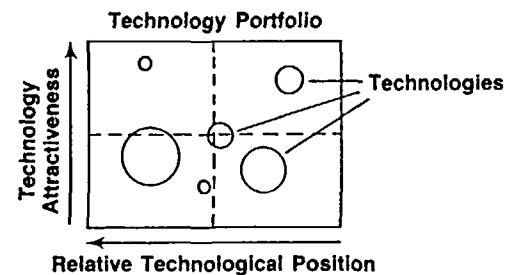
### How the Concept Works

The concept of the corporate portfolio of technologies facilitates the technology management and strategy development process (Exhibit 7). The concept provides a mechanism for allocating corporate technological resources and for establishing corporate technology priorities among numerous technology programs and projects. It does this by grouping, in a preliminary manner, a multiple of individual technologies into several categories, each category having a particular role in the corporate portfolio of technologies. There-

**EXHIBIT 6**  
Technology-Business Interface



**EXHIBIT 7**  
Technology Portfolio Concept



fore, the technology portfolio reduces the number of corporate technology alternatives and makes it possible to analyze them in a systematic fashion.

The technology portfolio balances technological resource allocation against technology attractiveness and importance and relative technological leadership. Perhaps the most important feature of the technology portfolio concept is that it is a quantitative and not just a qualitative approach. A simple and quantifiable approach is mandatory to assure management consensus and commitment to implementation.

Developing a corporate portfolio of technology involves dealing effectively with two categories of difficult and interrelated issues:

- Defining technology units.
- Quantifying the two fundamental dimensions that categorize a technology in the portfolio.

## Defining Technologies

Correctly defining a corporation's technologies or technological units is the most critical and the most difficult element in the development of both a technology portfolio and a technology strategy. A definition of a technology that is too broad causes unnecessary dispersion of technological resources and frequently leads to a loss in technological leadership to a more focused competitor. A definition of a technology that is too narrow leads to a retreat into indefensible technological segments.

A technology unit is a specific set of technological expertise and activities in which a company should participate in order to be able to achieve and maintain a superior and long-term defensible position of technological leadership which, in return, is required for achieving the company's business objectives. Therefore, the technological unit represents the smallest set of expertise and activities for which a relatively independent strategy can be formulated.

## Assessing Position and Attractiveness

The appropriate dimensions along which to categorize a technology in a technology portfolio are:

- Relative technological position.
- Technology attractiveness.

This first dimension measures the technological position of a firm in a particular technology relative to its technological competitors. Although a large number of parameters can be used to measure the degree of technological leadership (e.g., a number of patents, new products introductions, peer ranking, number of publi-

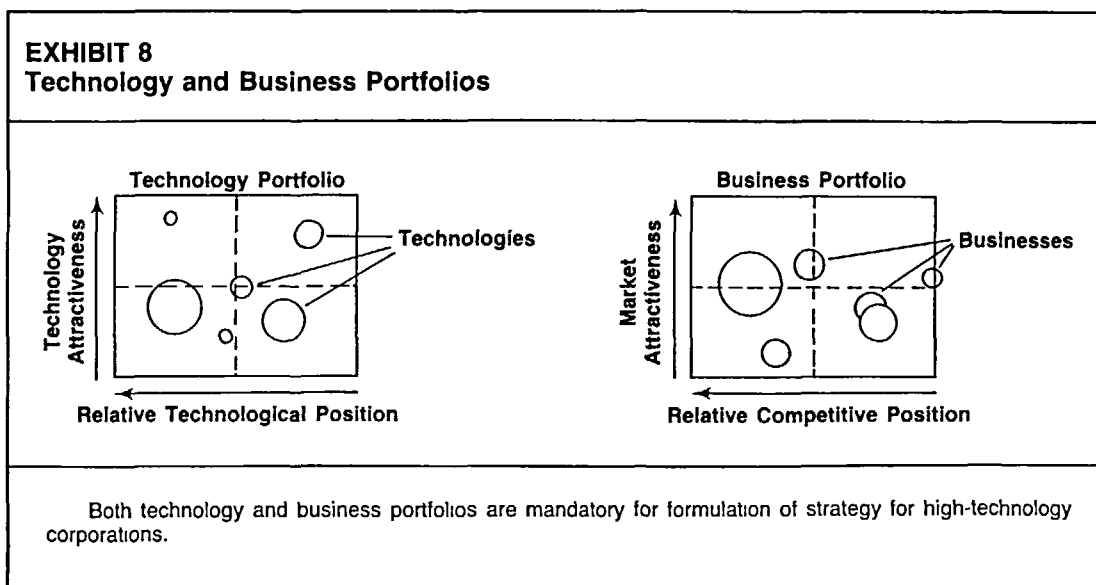
cations), such measures are of limited relevance and difficult to quantify and rank.

In the long run, relative technological position tends to be closely related to the cumulative investment in a particular, properly defined technology. Therefore, the sum of R&D and capital investments in a particular technology provides a useful first-cut measure of technological position.

Technology attractiveness measures the potential reward for investing in a technology and the potential for changing competitive positions in that technology. A useful measure of technology attractiveness, therefore, is the growth of all applications for that technology factored by a coefficient that reflects the criticality of the technology to each of the applications. This dimension really measures the need for achieving technological proficiency. Another frequently suggested measure is the rate of technological change. These two measures are, however, related: the rate of technological change is tied to economic forces—to expectations of the impact of improved performance or lowered price on the size and growth of applications for a technology.

Technology and business portfolios provide two fundamentally different views of a corporation. When they are integrated, they provide a foundation for developing corporate strategy. Both technology and business portfolios are mandatory for formulation of strategy for high-technology corporations (Exhibit 8).

- The technology portfolio provides a summary picture of the corporation's technological position and a mechanism for corporate focus and concentration on critical technologies.
- The technology portfolio provides an assessment of technological resource requirements for achieving



and maintaining a position of technological leadership.

- The total investment requirement in the corporation's technologies can be assessed and the prioritization and timing in allocation of these scarce technological resources can be made.
- The portfolio identifies positions of strength to be leveraged on and particular technologies that need to be acquired in order to achieve corporate business objectives.
- It provides a basis for initially identifying additional business opportunities that would utilize current corporate technological strength.

The simplicity of the technology portfolio framework should not be misleading. Its applications to specific situations is extremely complex, and it is here that broadly based strategy and technology experience is most important.

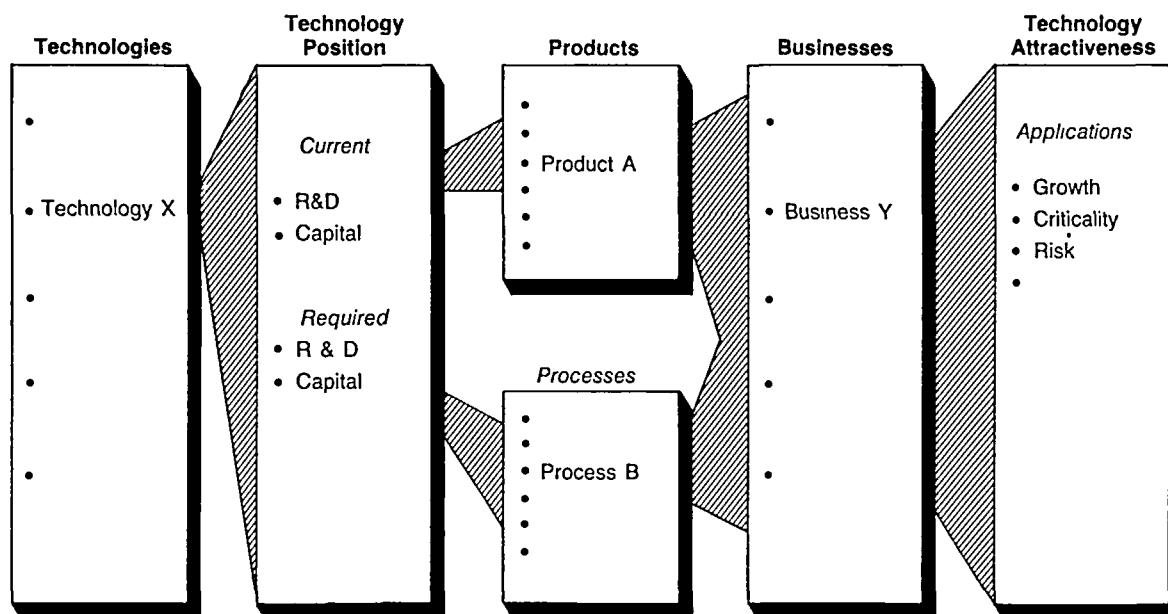
### The Key Questions

The process of defining the corporate portfolio of technologies is illustrated in Exhibit 9. The analysis is con-

ducted in a highly iterative fashion, and such specific questions as the following should be addressed:

- What are the technologies within the corporation?
- Which technologies are utilized in the firm's business? products? components and parts?
- How critical is each technology to each of these products and businesses?
- Which of these technologies are shared among different products and businesses?
- Which technologies are contained in purchased parts and material?
- Which of these external technologies might become critical and why? Will they remain available outside the firm?
- What was the evolution of these technologies over time? In which companies were these technological changes initiated?
- What is the likely evolution of these technologies in the future?
- What have been the firm's investments in critical technologies over time?
- What were the investments and investment patterns

**EXHIBIT 9**  
**Process of Technology Portfolio Formulation\***



\* The technology portfolio analysis is conducted in a highly iterative fashion.

Note: Although frequently used, the classification of technologies into products and process technologies has its limitations. Every technology has attributes of both. Over time their relative importance changes.

of its leading technological competitors? Historical? Planned?

- What has been the investment in the product and in the process side of these technologies? For the firm and for its competitors? Design? Production? Implementation and service?
- What is the subjective ranking of different firms in each of these technologies?
- What are the firm's businesses and products?
- What are the parts and components of these products?
- What is the cost and value-added structure of these parts, components, products, and businesses?
- What has been the historical financial and strategic performance of the business, and what are the implications of these trends? In terms of cash generation and earnings characteristics? Investment requirements? Growth? Market position and market share?
- What are the applications of the firm's technologies?
- In which does the firm currently participate and why? In which does the firm not participate and why?
- How attractive is each of these applications as an investment opportunity in terms of its market growth, its potential for profit improvement, and/or its potential for increasing technological leadership?
  - Underlying growth characteristics?
  - Evolution of customer needs and requirements?
  - Current and emerging market segments; segment growth rates?
  - Competitive positioning and likely strategies of key competitors?
- How critical are the firm's technologies to each of these applications?
- What other technologies are critical to the external applications?
- How do the technologies differ in each of these applications?
- What are the competing technologies in each appli-

cation? What are the determinants of substitution dynamics?

- What is and will be the degrees of technological change in each of these technologies?
- What are the applications that the firm should consider entering?
- What should be the priorities of technological resource investment?
- What technological resources are required for the firm to achieve its current business objectives?
- What should be the level and rate of corporate technology investments?
- Which technological investments should be curtailed or eliminated?
- What additional technologies will be required in order to achieve the current corporate business objectives?
- What are the implications of the technology and business portfolios for corporate strategy?

### **Conclusion**

Superior management of critical technologies is mandatory for high-technology companies. In most cases, however, this means management of innovation or technology commercialization rather than management of the invention. Although the issue is somewhat controversial, we have not found compelling proof that the period between the basic invention and its commercialization is shortening. This means that basic research alone does not determine the ultimate technology positions in business applications. A successful technology company is the company that identified the opportunity and focused its resources, leading to technology commercialization.

For a corporation with a diverse mix of businesses and technologies, the analysis of technology and business portfolios is mandatory for long-term sustainable superior corporate performance.