Technical Innovation: Options for Developing Countries

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IN THE year 2000, Intel earned a whopping $10 billion profit after taxes. Cisco's sales exceeded $14 billion, barely a decade after the company went public. Wal-Mart transformed itself from a regional retailer of the Seventies to a $200 billion behemoth. Banc One emerged from its small-town beginnings to join America's top ten banks.

These are successful firms, belonging to different industry groups, but bound by a common thread: they all employed technological innovations to achieve superior performance. Intel and Cisco invented the microprocessor and router technologies, respectively, and successfully commercialised them. Wal-Mart and Banc One created unique linkages in their operations by using information technology and gained cost and differentiation advantage over rivals.

In a dynamic, global business environment, technological innovation is imperative for competitive success. A firm must frequently pioneer new products, enhance current products, or create a unique operational system. However, not all firms emerge victorious in the innovation game. The road to the innovation altar is littered with more dead bodies than living exemplars. Many fail because they make half-hearted attempts or cannot recognise the profit potential of an invention. If they do, they cannot profitably exploit it. Others fail because they cannot stop competition from imitating their invention.

Business history is replete with stories of innovation failures and missed opportunities. NCR, a recognised leader in electromechanical cash registers, could not develop an electronic cash register. Xerox invented the personal computer and the laser printer but did not see a viable market for them. RCA, the broadcasting giant, chose not to invest in FM technology. EMI invented and commercialised the CAT scan but could not sustain its leadership position in that technology.

What is technological innovation and what should a firm do to be a successful innovator? Should technological innovations focus on developing new products only or are there other types? Should an innovator be also the inventor of the underlying technology to realise significant profits? How can developing country firms, with limited financial resources and a long tradition as low-cost production sites for the developed world, fully participate in the expensive technological innovation race?

**Technological innovation?**

Management scholars define technology as 'technical knowhow'. When IBM says that it has the computer mainframe technology, it means that it has the knowhow necessary to design and make computer mainframes. Similarly, Citibank would say that it had the technology or the knowhow to offer personal and electronic banking. Technology is thus technical knowledge necessary for making products or serving customers and it can be competitively managed. Innovation is the commercialisation of a technical idea or invention. Invention results in scientific/technical research. When developed and marketed as a product, an invention becomes an innovation. Innovation can occur in a product's components or how they are linked. Framed in this way, innovations are radical when they fundamentally change the product's components and linkages (for example, transistors altered the components and linkages in a radio) and incremental when current components and linkages are refined (for example, LP records refined 78 RPM but did not alter the gramophone technology). Innovations that change the components only (for example, fuel injection system replaced the carburettor) are called modular whereas changes in linkages only (example, a PC as compared to a mainframe) are called architectural.

However, innovations do not occur in component design and architecture only. They are also possible in materials procurement and logistics, manufacturing, packaging, marketing and distribution, and in how customers are served after sales.

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Product innovations

Inventions are the prerequisite for innovations. Inventions require determining the area of research focus, followed by investments in human and physical assets for conducting research. An additional and more important requirement is a work culture that management fosters to induce creativity. Many firms employ fantasy and imagination-building techniques for this purpose. For example, at DuPont, researchers are encouraged to frequently narrate their dreams to colleagues. Kodak's technical personnel are trained to communicate metaphorically. Hoechst Celanese employees play imagination-enhancing games with the help of creativity trainers.

General Electric and Xerox use ‘story-boarding’ - employees use white boards in common areas to sketch designs that are incrementally shaped and redesigned by others. Boeing engineers use ‘mind mapping’ - an individual draws a diagram in the centre of a paper and others draw related ideas as branches growing out of a tree. Psychologists and management scholars suggest that such techniques that build fantasies are fundamental for generating revolutionary ideas.

Inventions are developed into products through successive stages of refinement and verification involving prototyping, designing and testing. It is important for an inventor to be quick to the market with its invention before competition does. Inventions are rapidly and successfully developed into new products when the firm uses flexible organisational arrangements that foster frequent interaction and information-sharing among the development stages such as engineering, manufacturing and marketing. A parallel processing of activities (compare a rugby game) among work-stages, as opposed to sequential processing (compare a relay race), is what is necessary for this purpose. Scholars suggest that parallel organisations cut waste arising out of rework, increase speed in processing, and enhance outcome effectiveness.

The profit potential is significantly higher for an innovator who also owns the patent to the invention. However, inventions are expensive and uncertain in regard to their technical feasibility. Developing country firms generally lack the resources needed to generate inventions and, as a result, prefer to license technologies from the West. But, in a rapidly changing global economy, the path to premium profits lies in creating proprietary technologies and competing in world markets under one's own brand name rather than under a licensing arrangement. Following are some economical alternatives to developing country firms that will allow them to fully participate in the innovation game.

Architectural innovation

(1) Focus on architectural innovation: It is less expensive compared to other forms. IBM never pioneered any PC components. Instead, it focussed more on the PC architecture to create a competitive difference. It used Microsoft's operating system, Intel's microprocessor, and Tandem's disk drives to create a unique PC architecture as opposed to Apple that designed most components in-house. Because its components were proprietary, Apple also had to design its own PC architecture, thus increasing the cost of its end-product. Likewise, Sony designed its first tape recorder by changing RCA's architecture (achieved through reverse engineering) and making it more sleek, rather than licensing the technology from RCA. This set the trend towards miniaturisation in subsequent tape recorders and other consumer electronic goods, largely through changes in design architecture. While comparatively easy and less expensive, architectural innovation generates equally significant profits like other types of innovations do.

Imitation is cheaper

(2) Imitate successful product innovators: During the early stages of their development, the Japanese never invested in basic R&D. Instead, they became adept in imitating West European and U.S. products. Seiko imitated Rolex's styling, Canon copied Xerox's features, and Komatsu copied Caterpillar's design. In the U.S., Crown Cork and Seal, a highly profitable can manufacturer, never pioneered new products but often followed the technological footsteps of American Can to become successful. The South Korean and Chinese firms presently imitate American products and technologies to achieve high visibility in international markets. Undoubtedly, imitation is a cheaper and effective alternative to pioneering. When done diligently, imitation can generate significant profits and, at the same time, control for R&D-related costs and risks.
(3) Cooperatively develop technologies: Cooperation with customers, suppliers, and competitors can reduce R&D costs and simultaneously enhance the quality of innovation due to the pooling of competencies. Singer Sewing Machine Company invented the electronic cash register jointly with Friden, its supplier. Friden's knowledge in electronics calculator technology helped Singer to develop a successful new product economically. In the Seventies, IBM, Motorola, Texas Instruments, National Semiconductor, and Advanced Micro Devices formed an R&D consortium called Sematech to develop new semiconductor technologies that would enable consortium members better compete against the Japanese. The pooling of competencies enabled these companies to develop unique semiconductor technologies at a low cost. Toshiba emerged as a $45 billion maker of electrical and electronic products, largely through innovations developed cooperatively with others with complementary capabilities.

Innovations are not restricted to breakthrough product technologies, they can also occur in other value-adding activities of a firm. Several manufacturers and service organisations have employed IT in innovative ways, in materials procurement (example, just-in-time), customer responsiveness, and total quality management (TQM). The focus is on process innovation that will minimise cost, maximise operational quality, or enhance customer service. For example, American Airlines developed a proprietary computer reservation system called SABRE that linked travel agents to its database and altered how travel agencies conduct business. American further sells listings on this system to other airlines, generating revenues that by some estimates are significantly higher than from flying the airplanes.

Federal Express developed a sophisticated package tracking system that, besides providing the company with a cost-quality advantage over rivals, established an operational standard for the overnight mail industry. Baxter International, a distributor of hospital supplies, developed a proprietary network technology called ‘analytic systems automated purchasing’ that revolutionised inventory management in hospitals. In the service sector, banks, hospitals, stock brokerage houses, and supermarkets have used IT to offer unique services to customers, altering the way products are marketed and sold in their industries.

The competitive importance of technological innovation has increased due to globalisation of trade. Until now, developing country firms have survived by licensing previous generation technologies and providing low-cost manufacturing havens to the technological pioneers of the West. But such standard and non-entrepreneurial techniques can only take firms in these regions so far. With global competition intensifying in geometric proportions, survival and profitability of these firms will hereafter depend on their demonstrated ability to develop proprietary products and market them internationally under their own brand names. The sooner companies in these regions embark on a ‘technological invention and implementation' strategy, the better it will be for their competitive survival and growth. With several economic alternatives available to do so, failure to make a serious endeavour is inexcusable.