
Strategic Management of Technology

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Abstract

The paper has been developed in the following way:

- To identify the key themes of managing strategic innovation and change;
- To study the technological factors which are responsible for Innovation and Change;
- To understanding both of the existing technological advances and the probable future advances that can affect the organization's products and services and general environment;
- To consider strategic options available to the entities threatened by new technology;
- To establish the need and importance of technological leadership;
- To establish an analogy between and technological and organizational progress;
- To analyze the strategic framework for knowledge, learning, and intellectual capital.

Introduction:

The prime driver of economic progress is technological innovation. Modern life is a triumph of innovation; the refrigerator, the air-conditioner, the radio, the closed body automobile, synthetic rubber and a host of other breakthroughs created a better life and ultimately made possible a mass consumer society. In the twenty-first century, one goal of both the society and organizations should be to foster the faster rate of technical progress since the technical progress is a key to elevating everyone's economic well being.

Generally, firms try to increase revenues and profits, and innovation usually accelerates both. Why, then, is successful innovation difficult? So much so that enhancing a firm's ability to innovate is often one of the top concerns of senior executives.

An innovation may reduce the cost of production enhance the value of a company's output or allow the company to reach new customers. It may either enhance or replace existing products, and it may do so by altering a product, a set of processes or both.

Frequently, one or more of four different barriers defeat innovation. **First**, innovations involve doing something new and sometimes cost effective technology may not be available to the company.

Second, innovations offer customers something new, and sometimes it turns out that they are not willing to pay enough for an innovative product or service.

Third, competing companies often introduce rival innovations.

Fourth, when companies innovate, they often must also change at the organizational level. Transforming an organization is often much more difficult and costly than introducing a new product or process.

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Managing innovation to create value is a complex, cross functional, historically dependent endeavor. It is a strategic challenge because innovation succeeds when they reach the right market at the right time with the right competitive positioning. It requires the management of change because innovations succeed when new ways of operating are aligned with new value propositions. (Michael et. al., 2004)

Technological Factors:

In order to avoid obsolescence and promote innovation, a firm must be aware of the technological changes that might influence its industry. Technical change is one of the core drivers of the organization. While technological change accentuates organizational failure rates, there is substantial heterogeneity in influence of organizational life. Some firms thrive during eras of ferment, other firms proactively destabilize their product class with technological discontinuities, even as most firms swept away during Schumpeterian gales of creative destruction. The stream of research on the organization and technology is interested in how organizations shape and are, in turn shaped by technological change. Creative technological adaptations can suggest possibilities for new products for improvements in existing products or in manufacturing and marketing techniques.

Technology and resource rich firms often fail to sustain their competitiveness at technology transitions. Consider SSIH, the Swiss watch consortium; Goodyear tire; Polaroid; and Oticon, the Danish hearing aid firm. These organizations dominated their respective world markets, SSIH and Goodyear through the 1970's and Polaroid and Oticon through the early 1990's. Each developed new technologies that had the capabilities to re-create their markets (e.g. quartz movements, radial tires, digital imaging and in-the-ear (ITE) volume and tone control). But although SSIH, Goodyear, Polaroid and Oticon had developed the technology as well as the resources to innovate, it was smaller and more aggressive firms that initiated new technology in these four industries. SSIH, Goodyear, Polaroid prospered until new industry standards-what we call dominant designs-rapidly destroyed their market positions.

In the watch, tire, photography and hearing aid markets, it was not new technology that led to the

demise of the Swiss, Americans, or the Danes; indeed SSIH, Goodyear, Polaroid, and Oticon were technology leaders. Nor was the rapid loss in market share due to the lack of financial resources or to Governmental regulations. Rather the rapid demise of SSIH and Goodyear and the losses at Polaroid and Oticon were rooted in organizational complacency and inertia. These pathologies of sustained success stunted their ability to reorient themselves. This success syndrome is particularly paradoxical among firms who had the competencies, resources and technologies to proactively drive innovation streams. In the innovation streams, some patterns of innovation have been built on and extended prior products and others have destroyed the very products that account for a firm's historical success. The paradoxical pattern in which winners with all their competencies and assets, become losers. This is found across industries and countries.

Conversion of a technical innovation to a marketable product and/or service requires trial, experimentation, redesign and retrial over a number of cycles. The specified materials and manufacturing methods used initially may be improved upon. Thus, there exist both technological uncertainty and the risk of obsolescence. The latter risk may result in the write offs or write down of the initial investment before the first revenue is earned. There are high initial cash outlays due to experimenting with various materials and processing methods.

There may be problems obtaining the type, or quality, of raw materials needed, or in obtaining tolerances and consistent quality of component parts. Inconsistent quality is often a significant problem. The pressure to produce marketable products and make initial sales often causes a short-term focus, resulting in expedient decisions being taken. Such decisions may adversely affect sustained market acceptance and sales growth.

Technological Forecasting:

A technological breakthrough can have a sudden and dramatic effect on a firm's environment. It may spawn sophisticated new markets and products or significantly shorten the anticipated life of a manufacturing facility. Thus, all firms and most particularly those in turbulent growth industries, must

strive for understanding both of the existing technological advances and the probable future advances that can affect their products and services. This quasi-science of attempting to foresee advancements and estimate their impact on an organization's operations is known as technological forecasting.

Some of the technological forecasting issues are:

- What is the current state of the technology?
- How will it change?
- What pertinent new products or services are likely to become technically feasible in the foreseeable future?
- What future impact can be expected from the technological breakthroughs in related product areas?

How will those breakthroughs interface with other considerations such as economic issues, social values, public safety, regulations and court interpretations?

Technological forecasting can help protect and improve the profitability of firms in growing industries. It alerts strategic managers to both impending challenges and promising opportunities. For example, advances in xerography were a key to Xerox's success, but caused major difficulties for carbon paper manufacturers.

The key to beneficial forecasting of technological advancement lies in accurately predicting future technological capabilities and their probable impacts. A comprehensive analysis of the effect of technological change involves study of the expected impact of new technologies on the general environment, on the competitive business situation, and on the business-society interface. For example, as a consequence of increased concern over the environment, firms must carefully investigate the probable effect of technological advances on the quality of life factors such as ecology and public safety.

Managing Strategic Innovations:

Building and running an organization that consistently generates innovation, are a difficult task because executive leaders must overcome powerful forces that hinder innovation. Paradoxically, these forces often grow stronger when and organisation become more efficient, capable, and successful.

This kind of innovation that leads to success over time is a recurring cycle. The firms encounter the technical and strategic challenges the change across these cycles. There is no best way to management the technical and strategic changes that firms encounter across the cycles. Breakthrough concepts lead to a period of ferment in which variants of a technology compete with each other. This can lead to disruption in some cases but it may reinforce the position of dominant firms in other cases. Eventually, the original innovation culminates in a dominant design, a standard configuration or architecture.

Managing innovation is an organizational problem. The operation of a firm affects its capacity to innovate and to adapt to the environmental changes that innovation brings. There is no single best way to organize a company that succeeds at innovation, and managers must maintain congruence among many different aspects of the organization. An organization's vision, culture, power structure, career paths, organizational design, and ability to transcend its own previous competencies are all important. Furthermore, innovative organizations must sustain different, parallel structures, of which some are designed to win today's competitive game and others that are configured to lead the next turn of the wheel.

Successful innovators think strategically when they do more than optimize the next innovation they intend to introduce. In addition to positioning individual, new products and services the strategists think in terms of innovation streams. Today's innovations must exploit today's competitive advantages and they must enhance the firm's dynamic capabilities to build new sources of competitive advantage for tomorrow. Tomorrow's innovations should not take today's terms of competition for granted. The value innovations are important because they change the rules by altering the logic that customers use to choose one vendor

over another. Companies master these challenges by managing a balanced portfolio of innovation projects.

Organizations innovate by increasing their knowledge base and deploying it in new directions. They expand their stock of intellectual capital by balancing exploration (enlarging the domain of what they know). Often, both types of learning involve giving to and gaining from "communities of practice", informal groupings of people and organizations who contribute to a common body of knowledge. Companies accelerate their ability to learn from such communities by building a web of relationships with complimentary knowledge producers and developing their absorptive capacity and the ability to acquire skills in a given arena. By developing mechanisms that promote the sharing of knowledge across organizational boundaries, they foster innovation that springs from the recombination of ideas that are developed in different settings.

As recombination is such an important source of innovations, the management of linkages across organizational boundaries is of vital importance. Frequently, innovations are brought to market by cross-functional teams, and managing such teams is a core managerial skill. Within an organization, executives forge and support linkages between sub-units and manage competition among them, promoting active experimentation and flexibility instead of destructive internal rivalries. Business units also coevolve with one another, deciding in a decentralized fashion how and with whom they can best collaborate.

Across organizational boundaries, firms innovate horizontally by acting as the technology brokers, combing existing knowledge from disparate industries. They innovate vertically by partnering upstream with their suppliers and downstream with their distribution channels to develop new products and services that create competencies throughout the supply chain.

In each of these seemingly disparate situations, innovation springs from the manager's ability to bring ideas and capabilities together across organizational boundaries.

Organizations have difficulties following through and changing their fortunes via innovation because so many other simpler and less disruptive activities compete for limited time, resources and talent. It takes strong executive leadership to overcome natural biases in favor of maintaining existing goals, processes, and organizational arrangements. Great leaders maintain a sense of urgency, pacing companies through cycles of convergence that are punctuated by upheavals. They impart a unifying vision that motivates employees to pursue innovations because they fulfill a shared purpose. At the same, they encourage initiatives that lie outside accepted trajectories even though they understand the risk of pursuing a vision so firmly.

Maintaining congruence as an organization changes from what it has been to what it will become requires managing the dual challenge of efficiency and adaptiveness through creating the change without chaos. Visionary leaders and strong executive teams surmount these problems; structures and systems alone do not. Clearly, one needs a broad, multi-disciplinary conceptual tool kit to manage the intertwined problems of creating value through strategic innovation and managing the organizational changes that flow from innovation. General Managers draw upon many different types of insight and knowledge to run an organization that can repeatedly use innovation to change the terms of competition in its favor. (Michael et. al., 2004).

Strategic Options for Entities Threatened by a New Technology:

Technical innovations can create new industries, and may modify, transform or destroy existing industries. However, products born of new technology do not swamp the market and replace existing products overnight. They evolve gradually and win market acceptance overtime.

An examination of market substitution pattern of new for old technologies shows that:

- after introduction of new technology sales of the old technology do not decline immediately because initially pioneering buyers are the only purchasers.
- in some instance, sales of old technology products continue to expand;

- the time period from the introduction of the new technology until dollar sales ranges from 5 to 14 years
- where entry costs are not excessive, new firms may be the first to introduce the new technology;
- the new technology often creates new markets which are not available to the old;
- products of the new technology are initially expensive and relatively crude;
- The traditional industry is often invaded by the new technology, capturing a series of sub-markets sequentially.

The response strategies of the firms threatened by the new technology include:

- Doing nothing and monitoring developments;
- Seeking to hold back the threat by lobbying or taking legal action;
- Increasing entity flexibility in order to have response capability if required;
- Avoiding the threat by decreasing dependence on the threatened markets;
- Improving the existing technology;
- Increasing sales promotion and/or cutting prices;
- Adopting the new technology.
- The rate of change and market adoption tends to dictate, determine, the appropriate strategic response. (Ron et. al., 1996).

Technological Leadership:

Firms must decide whether to lead or follow in the marketplace. Either approach can be successful, but each requires a different strategic posture. Therefore, many firms state an objective with regard to technological leadership. For example Caterpillar Technological Company established its early reputation

and dominant position in its industry by being in the forefront of technological innovation in the manufacture of large earthmovers.

Recent studies of companies over long periods show that the most successful firms maintain a workable equilibrium for several years (or decades), but are able to initiate or carry out sharp, widespread changes (reorientations) when their environmental change shift. Such upheaval may bring renewed vigor to the enterprise. Less successful firms on the other hand, get stuck in a particular pattern. The leaders of these firms either do not see the need for reorientation or they are unable to carry through the necessary frame-breaking changes. Those organizations which do not initiate reorientations as environments changes if they do not undertake necessary changes, tend to underperform.

Managers of E-commerce technology will have more of a strategic role in the management hierarchy in future as the internet has become an integral aspect of the corporate long-term setting. By offering high level of responsibilities to the a-technologically managers, a firm pursuing the leadership position in terms of innovation in computer networks and systems. Officers of e-technology at GE and Delta Air have shown their ability to increase profits by diving down transaction costs with web-based technologies that seemingly integrate their firm's supply chains.

The above technologies have the potential to "lock-in" certain suppliers and customers and heighten competitive position through supply chain efficiency.

Technological Progress and Organizational Progress :

There is an analogy between technological and organizational progress. Most people believe that the greatest technological advancement in the development of modern lighting was made when Edison invented the electric light bulb. However, Edison's invention was a distant and clearly inferior relative to the light bulbs we have today. True, Edison creation represents a paradigm shift that resulted in the world moving from gas to electricity but afterward there were hundreds of smaller changes that gradually created the light bulb. In other words, the paradigm

shift established a foundation upon which to improve but the cumulative effect of all these smaller changes has been more significant than the initial improvement from gas to electricity.

The methods of achieving growth are widespread among the major corporations. The corporations recognize that technological innovation is central to improving productivity, developing new businesses and generating sustained long-term value. High levels of R&D expenditures are required by the corporations for the development of new products and services. The corporations also recognize that innovation requires commercialization. There is little value in investing in something that is never commercialized. The superior technology by itself is not sufficient for a successful business. (Peter et. al., 2005)

Significant advances takes place through both evolutionary and revolutionary changes and both single and double-loop learning. The double-loop learning entailed in shifting paradigms establishes a new world as well as a new order of things. But it may take the organization years, even decades to fully realize the potential gains that the new paradigm carries with it through a long period of single loop learning.

The classic example of a single lop learning is the thermostat. Upon discovery of a deviation away from a prescribed temperature, the thermostat triggers the pre-programmed action of heating or cooling. For example, if thermostat were capable of changing its operations on the basis of the wisdom of its programming and adjust it accordingly it would be capable of double loop learning. In other words, double loop learning entails questioning and adjusting the underlying policies and objectives that shape the way in which the organizations operate.

Therefore, in order to maximize their progress, organizations must be capable of maximizing both types of learning. In other words, an organization needs to be dynamic enough to cope with the double loop learning, but stable enough to make steady progress through single-loop learning during the periods of relative equilibrium. However, many

managers see this as asking too much of them and of their organization. Tom Peters reports that many would-be-leaders are stymied by what he sees as the ultimate catch-22: "Success is the product of deep grooves. Deep grooves destroy adaptability that is key to success". According to Peter, the success through deep grooves depends on a commitment to holding things relatively stable while endless evolutionary changes are made, an indication of strong faith in current paradigm.

However, the faith in the paradigm that deep grooves represent also limits an organization's willingness to break out of the groove and make revolutionary changes. In Peter's view, too many managers want to focus on making progress through evolutionary changes (digging deeper grooves) or revolutionary changes (jumping out of the groove) while the need of their organization is a combination of both types of progress.

All of these suggest that organizations need to be proficient at both single-loop and double-loop learning.

Knowledge, Learning and Intellectual Capital- A strategic Framework:

In the knowledge economy, a key source of sustainable competitive advantage and superior profitability within an industry are based on how a company creates and shares its knowledge. Currently for the managers, developing new other strategic management tools to ride the waves of innovation cycles. Unilever, one of the world's largest fast-moving consumer goods companies has been particularly active in knowledge management for the past 10 years and has achieved measurable results from these activities such as a the faster rate of innovation, increased efficiency in manufacturing and supply chain and an acceleration of rolling out best practices.

For sometime now, Unilever managers have been convinced about the role of knowledge as a key differentiator, and hence an investment in innovation is substantial. Unilever's Corporate Purpose states "We will bring our wealth of knowledge and international expertise to the service of local consumers....." But as the company has become more focused, and bottom-line improvements are bearing fruit, it is becoming increasingly important to ensure

that investments in knowledge contribute truly to top-line growth and profitability. In Unilever's Culinary Category, the management and development of knowledge and creativity are seen as a strategic priority and approached through a new way of strategizing for knowledge and innovation.

Knowledge creation and its transfer has been a key to the development of the Culinary Category-which was formed in 1996 and covered products such as meal sauces, cold sauces and cooking ingredients. A knowledge initiative has been in place within this category since December, 1996. In order to capture what the company knows and does not know in various functional and product areas, knowledge workshops have been organized to bring together key experts and practitioners from around the world. In a facilitated and structured way, learning and understanding are discussed and captured. Among the key results are a shared vocabulary and terminology such as the initiation of a Community of Practice (CoP), and the identification of knowledge gaps. (Michael et. al., 2005).

Conclusion:

The methods of achieving growth are widespread among major Corporations. The Corporations recognize that technological innovation is central to improving productivity, developing new businesses, and generating sustained long-term value. High levels of R&D expenditures are required by the Corporations for the development of new products and services. The Corporations also recognize that innovation requires commercialization. There is little value in investing in something that is never commercialized. Superior technology by itself is not sufficient for a successful business.

Technology leaders are proficient at understanding changing customer needs, technological developments, and the strategies of both direct and indirect competitors to ensure that their leadership position is maintained. Firms active in R&D attempt to create a virtuous circle. These firms use their high margins to invest in R&D to develop innovative products which have high growth rates and margins and in turn support a further cycle of R&D. Such leaders are close to markets ensuring that technology is used

to create new products that customers require with a substantial advantage over current products. These firms attempt to maintain leadership through their development and use of technology. The empirical evidence suggests a strong positive relationship between R&D spending and corporate profitability. (Peter et. al., 2005)

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