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1.2.5 Technology strategy for innovation

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1 Internal and external factors

From the perspective of strategies for realizing innovation, let us examine the issues that need to be considered in the series of processes involved in strategy formulation, decision making, and implementation. Simply put, strategy is a path by which to advance both the external factors surrounding the company (i.e., external environment) and the internal factors of the company (i.e., internal organization) as far as possible in accordance with one's intentions. However, self-serving intentions and goals can never be achieved, because they cannot be controlled as intended long enough to be sustainable unless they provide meaningful value to customers. Technology strategy has two dimensions: one involves using technology to "maintain and strengthen" existing strengths and market positions, while the other involves destroying one's own strengths and market positions and "transforming" one's market environment. Technology is inherently neutral and can be used both to maintain and enhance existing systems or to disrupt and transform them.

Therefore, technology strategy starts by considering the social context in which the technology is intended to be used. In other words, the question is whether the technology in mind should be envisioned as a weapon by which to maintain and strengthen the existing system or with which to negate and transform both it and the industry structure.

Another important factor when considering technology strategy is a company's existing accumulation and the extent to which it serves as a source of differentiation from other companies. If the company has an accumulation of technology, the direction of its technology strategy should be to dig deeper into its own strengths. On the other hand, if the company lacks accumulation, the technology strategy should be directed toward the acquisition of new capabilities.

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In short, the focus of a technology strategy will vary greatly depending on how one expects the development and commercialization of a new technology to become a common part of society. When considering technology strategy, we should begin by asking the following questions:

1. What is the specific time horizon (e.g., five, ten, twenty, or more years?) that you envision when developing your strategy?
2. How will the industry structure change in that timeframe? What are the key factors behind this? How do you want the industry structure to change, and how do you want your market position to change within it?
3. What should your company do to gain an advantage over other companies in implementing the changes above?
4. How can the company's existing management resources (e.g., skills, know-how, brand, technology, and organizational practices and culture) be utilized? In particular, how can you take advantage of your technological assets, human know-how, and the organizational practices and culture that support them?
5. What are the new know-how, skills, and abilities that must be acquired in order to establish a leading position within the changing industry structure? What are the key competencies, especially in the technical areas you have in mind?
6. If the existing organizational structure cannot handle this, what kind of organizational structure should be used to build new capacity?

2 Technology strategy that draws upon existing capabilities: Core competencies

Every company has strengths that are unmatched by its rivals, albeit to varying degrees. Believing that these do not exist is usually only a matter of perception. What we can do as a matter of course from our own perspective may itself be a threat from the perspective of other companies. Technology strategy thus begins with the recognition of strengths that are competitive with those of other companies and the sharing of this recognition among the members of the organization. The basic starting point for a technology strategy that leverages internal factors is to recognize the ability to not only be competitive, but provide value to customers by “outperforming” other companies, and the ability to do so in a way that other companies cannot easily imitate. These capabilities are commonly referred to as “core competencies” (Itami, 1984; Prahalad & Hamel, 1990).

This capability is not a visible competitive edge as measured by external measures of success (e.g., profit margin) at the product or business level, but an invisible competitive edge (Fujimoto, 2004). The emphasis is not at the product or business level, but on organizational capabilities as a common foundation for creating multiple different new products and markets. The capability to create new products and services is sometimes called “dynamic capability,” insofar as it involves the ability to create new adaptive capability

(Teece, Pisano, and Shuen, 1997). For example, Ajinomoto's in-depth exploration of amino acid technology as a proprietary technology has set the company apart from its rivals around the world. Indeed, the company has become a driving force for the creation of other new businesses in the food industry, as well as a key player in the global restructuring of the food industry. Achieving high profitability in electronic components rather than rapidly expanding and creating technological silos, Murata Manufacturing has been conscious in identifying the technological fields in which it dominates its competitors in ceramics technology fields (Itami, 2003). Honda, well known for its motorcycles and automobiles, has positioned engine development as a core technology and is attempting multifaceted development centering on mobility from lawn mowers to walking aids, motorcycles, and automobiles. Its entry into the aircraft industry in recent years has been facilitated by its accumulation of engine design and development and airframe design knowledge cultivated over the years to combine fuel efficiency and comfort.

Sustained core competencies are supported by embodied and organizational skills. In order to maintain sustainable core competencies, it is necessary to clarify what the company's core technologies are, and trace them back to market opportunities—and the customers who constitute those opportunities—where they can continuously manifest as strengths. While the task of clarifying and deciding what the core technologies are is not something that can be decided by people in the field or in the middle, it is something that should be decided within a long-term scenario and determined by management.

Focusing only on emerging market opportunities prevents us from identifying the core capabilities that we should have. Building a capability that can respond to changes in the environment—that is, a core capability—requires the development of elemental technologies over a long period of time. This starts with the identification of future market opportunities (i.e., the challenges faced by future customers). This can never be achieved by short-term, day-to-day accumulation of capability.

The following excerpt hints at the inevitable consequence of short-sighted action: “A market analysis-oriented strategy, in which the strategy is based on the needs of the market, runs the risk of scattered, shotgun-blast results, and the risk of chasing behind market trends, including those of competitors. In other words, if you focus on market analysis and begin your strategy from already-extant needs, ‘you may find that the needs that are new to the marketer and the organization to which the marketer belongs are already familiar to the market’. What awaits the product is a multitude of competitors, and price competition with products of similar design” (Ishii, 2009).

3 Technology strategy as capacity building: Stretching and learning

However, it is rash to assume that sustainable growth is guaranteed if the company has core technologies that are superior to those of others. This is because the socioeconomic value of core technologies declines over time as other companies develop new technologies and/or catch up with their own proprietary core technologies. Accordingly, it will be more important in the long run to conceptualize and build a technology strategy from the perspective of whether the company has its own core competencies and how they can be applied to existing or new businesses on the one hand, and how the company can build “new” core competencies that differ from existing ones. In strategy theory, leveraging the capabilities and resources

you already possess is known as a leverage strategy, while acquiring new capabilities and resources is known as a stretch strategy (Hamel and Prahalad, 1994). Trying to build new core competencies is just one stretch strategy.

A stretch strategy is a strategy to bridge the gap, so to speak, between the current situation and the goal—that is, something that cannot be achieved at present, but can be set as a goal to be achieved by a deadline. A stretch strategy is the means by which to close such a gap. The key to the process of implementing this strategy is learning at two levels, namely, that of the individual and that of the organization. In other words, the stretch strategy for creating new core competencies is to decide which specific challenge goals to set in advance and in which technical areas, and to determine a path by which to encourage both individual and organizational learning toward these goals. Research and development activities pertain to identifying in advance the challenges that customers will face in the future, discovering and replicating technical solutions to those challenges, and providing them to customers in the form of products and services. This is very much a learning process in problem solving by the people involved in this activity. In this sense, whether or not R&D activities are properly advanced depends on whether effective organizational learning occurs in various places within the organization. A technology strategy that encourages capacity building is also one that encourages organizational learning. This requires us to consider the following:

1. A healthy sense of urgency: Humans are weak beings. We fixate on the short-term, tangible goals, and find it difficult to challenge intangible, vague, and long-term goals. As such, the starting point is to conceive of technological strategies based on the premise that we are weak. For example, the slogan of Under Armor, a fast-growing sportswear company, is, “We have not yet created a definitive product.” Within this is the premise that the perception of imperfection serves as a challenge to create something more perfect.
2. Difficult environment and customers: There is an aspect to being weak that encourages learning by daring to put oneself in a difficult environment. As a strategy to encourage learning and temper your skills, you can choose to work with customers who have strict specification requirements, or dare to choose the technology or customer area with the most stringent specification requirements. Rather than considering compatibility with current capabilities, this is a strategy of daring to enter an incongruous area with a view to building and refining future capabilities (Itami, 2003). Such a strategy expects customers to promote capacity building. Only when you have a focal point with your belligerent and demanding customers, will you be able to build a relationship with your future customers.
3. Start small and learn from mistakes: Experimentation is essential to promoting learning, and often involves failure. Therefore, in order to encourage learning, we need to encourage experimentation (i.e., trying things out) without fear of failure on the one hand, and to learn from our mistakes on the other. One measure to encourage experimentation is to institutionalize learning. Formalizing the allocation of a certain percentage of work time to non-routine tasks, such as 3M’s 15 percent rule or Google’s 20 percent rule, is one example. Another example is the “boundaryless” initiative

promoted by Jack Welch, president of General Electric (Welch, 2001). What is more difficult is developing an attitude of learning from mistakes and building a culture of learning from mistakes. Despite failure being a source of knowledge for future advancement, we are implicitly taught that failure is something to be avoided. However, the causes of failure are not uniform. Failures should be divided into “preventable failures” resulting from simple negligence, “unavoidable failures” resulting from complexity, and “intellectual failures” in advanced areas, with different stances adopted toward each type (Edmondson, 2011). In order to prevent major fatal mistakes, we must start small in order to reduce physical and psychological hurdles.

4. Narrowing down the company’s domain (i.e., areas of activity): Even if we accept the significance of trying things out and learning from mistakes, it is a fact that management resources are limited. One should not get involved in a new business or technology simply because it has growth potential or because it is technically feasible for your company. The area of business activities that a company should engage in is also known as its “domain.” As management resources are limited, it is necessary to thoroughly narrow down the business areas in which a company should engage. If you launch new businesses according to immediate growth potential without a clear definition of the area of activity, you run the risk of winding up with a collection of unrelated businesses as a result.
5. Learning from the periphery: Innovation is said to come from the periphery. New ideas that are not moonshots often come not from the center of an organization or market, but from the periphery or frontier—that is, the not-so-moonshot places to which few people pay attention. This is because existing principles and practices, which are extensions of the past, dominate the cores of organizations and markets, and new principles, practices, and ideas are ignored or discarded as anomalies that are incompatible with existing systems (Hamel & Breen, 2007). In recent years, some have focused on the positive significance of the periphery, terming it “edge strategy” (Lewis & McKone, 2016). According to these discussions, a periphery is not just a frontier, but a crossroads of different ecosystems (e.g., forest fringes, coastlines, and wetlands) where populations combining the characteristics of both ecosystems live. The populations there may be unique insofar as they are heterodox and peripheral to both ecosystems, but also adaptive to the principles of both ecosystems. Likewise, in business, new opportunities can emerge in places that are considered peripheral by the principles and practices of existing markets and organizations. An innovation seems improbable before it happens, but obvious after the fact. Therefore, in order to explore the possibilities of innovation, we must not look at the mainstream but at the periphery, as well as at the trends in the field where different peripheries intersect.

4 Technology strategy as a weapon to maintain and strengthen industry structure

Developing new technologies and focusing on capacity building to help solve customers' problems are not the only objectives of technology strategy. Technology strategy is also used to maintain your position or transform your external environment. In a sense, technology development and technology strategy can be positioned as weapons to better manipulate the external environment to one that suit us, either by using existing technologies or developing new technologies. This is the other dimension of technology strategy.

As is well known in strategy theory, the external environment surrounding a company can be characterized by six forces that define the potential profit level of the industry structure (Brandenburger & Nalebuff, 1997; Porter, 1980): existing industries, possible new entrants into existing industries, substitutes, sellers, buyers, and complementary goods. Existing industries, (potential) new entrants, and substitutes compete for customers in terms of whether they buy from existing industries, new entrants, or substitutes. Accordingly, from the perspective of downstream customers, the potential profit level of the value chain in question will decline as the potential for new entrants increases or as substitutes emerge. Moreover, while buyers and sellers are collaborators in building value chains, they are also competitors, as they share the value created between downstream and upstream.

Examining the structure of the industry from the perspective of these six forces offers a framework for examining the latent and apparent factors that expropriate profit from the amount of bargaining power. It also provides a perspective that can be applied to technology strategy. More specifically, the strategy is to position existing technologies or new technologies under development to maintain and strengthen bargaining power with competitors, new entrants, substitute suppliers, sellers, and buyers in existing industries, or to transform existing industry structures and create new industry structures. As shown below, the basic strategy involves using your own technology as a weapon to nullify the social, economic, and technological value of products and services developed by other companies.

1. To what extent can the technology in question (which has already been developed or is under development) nullify the value of competitors' products and services?
2. To what extent will the technology in question act as a barrier to prevent new vendors from entering the market (i.e., barrier to entry)?
3. To what extent will the technology be able to nullify the value of substitute and complementary goods?
4. To what extent is the technology capable of nullifying the bargaining power of the buyer (seller)?

5 Technology strategy as a weapon for changing and creating industry structure

However, a technological strategy based on the external environment is not only important in terms of nullifying the value of other companies and making the value created proprietary to your company instead.

Indeed, the development of new technologies and technological advances based thereon can be an opportunity to change relationships with competitors and collaborators within the existing industry structure and create a new industry structure. Transforming one's competitive environment through the development of new technologies is another objective of technology strategy.

The increasing sophistication of electronic control in the automotive industry is creating opportunities for new entrants from different industries to enter the industry, and is becoming an opportunity for change in the current industry structure. The entry of Apple and Google into the automotive industry is one such example. Moreover, advances in image sensors and the higher quality and lower price of photographic equipment have lowered the barriers to entry for video recording, creating a situation where video production is open to larger numbers of ordinary people. Consequently, TV content, dominated by broadcasters and specialized production companies, is now competing with video content, which is primarily produced by amateurs, on the Internet, providing an opportunity to change the advertising business model accordingly. The purpose of technology strategy is to encourage changes in the competitive environment through technological innovation.

Considering the state of technology strategy from the perspective of trends in the external environment surrounding the company is a perspective that was not necessarily important in the days when the dominant business model was a vertically integrated one in which the company controlled everything from upstream to downstream. This is because vertical integration once made it easier to control the external environment. However, if we take into account the shift in dominant business models from vertically integrated businesses to horizontally distributed business, and the possibility that the various business partners that exist between a company and its end customers may affect the realization of innovation, we must pay more attention to the changes in the external environment surrounding our company than ever before.

Ron Adner (2012) noted the need to focus on the dependency on industry structure in achieving innovation, arguing that we must pay attention to execution risk as well as co-innovation risk and adoption chain risk. Here, execution risk is the risk of being able to provide what customers need better than competitors, while co-innovation risk is the risk that the realization of the innovation you are promoting depends on the commercialization of other innovations. Adoption chain risk is the risk that collaborating business partners will accept the company's innovation in providing value to the customer. In this regard, emphasis is placed on dependencies on others to achieve innovation that can only be realized through collaboration; this is also known as an ecosystem. As an example, Adner cites the PAX system, an innovative tire that was introduced by Michelin as a run-flat tire that can continue to run even after a puncture in order to show how the company overlooked the role of repair shops in the process of introducing innovative products.

Transforming relationships with business partners through the development of new technologies is feasible on many levels. For instance, consider a case where a strong upstream seller (e.g., a component or materials supplier) has more and more of the value of the entire value chain, while the rest of the downstream companies are robbed of their profits. In such a case, in order to change its relationship with sellers who have high bargaining power and transform the industry in the direction of reducing bargaining

power, the upstream seller industry must become more pro-competitive than in the past. Meanwhile, downstream companies should expand their business with suppliers other than the specific seller taking their profits, and make long-term transactions with a view toward capital support and technical cooperation. It is possible to improve long-term relationships with sellers by nurturing sellers besides the second-largest seller and improving their ability to compete. The same measures should be taken for sellers when the performance or price of complementary goods forms a bottleneck preventing the diffusion of their products or services. In other words, the strategy is to position the direction of the company's technology development so as to make its complementary goods industry competitive in terms of both technological progress and price. Technology development strategies should be conceived and implemented to increase the value of one's own products, as well as nullify or check the technological development of others and eliminate bottlenecks. In this regard, technology development strategies should be conceived and implemented not only for sellers and complementary goods, but to delay the technological progress of the substitute goods industry and increase the likelihood of nominal purchases by buyers.

6 Traps and challenges in developing and implementing a technology strategy

6.1 The core capabilities trap

Management policies that concentrate management resources on the technological strengths that the company has accumulated in order to enhance its competitiveness are rational measures to build core competencies. However, there are a few points to keep in mind when developing and implementing a technology strategy that aims to build core competencies. The first is the issue of defining and sharing core competencies. Core competencies themselves are often elusive and difficult to recognize, identify, and share because they are invisible and deeply embedded in day-to-day business activities. Therefore, as more and more members of the organization participate in the business process, it becomes increasingly difficult to share perceptions of what the core competencies are. The second issue is that core competencies in technical skills tend to be overestimated because high applicability and versatility in different domains are defined as core competencies. The third issue is that competencies are embodied in people themselves and in human-human collaborative processes, and are thus deeply connected to organizational culture and practices. As such, core competencies cannot change in the short term. In other words, core competencies are both a strength and a weakness insofar as they can turn into a weakness when the environment changes. Core competence is also a source of rigidity (Leonard-Barton, 1992).

6.2 Rules, norms, and evaluation criteria for existing business

When the development of a new technology is driven by the proposal of a new business or new business model, the promotion of the new technology often faces difficulties because the market opportunities brought about by new technologies are evaluated by rules, codes of conduct, and evaluation criteria based

on existing businesses (Johnson, 2010). For example, the market opportunity for a new technology may be too small or low-margin compared to the market opportunity that an existing business has exploited. Alternatively, it may not meet internal quality standards, and its customer base may be very different that targeted by incumbent companies. At that time, existing rules, codes of conduct, and evaluation criteria, which embody the essence of the success of existing businesses in the past, are not useful for understanding the market opportunities opened up by new technologies; rather, they are used as a rational basis for underestimating new opportunities.

One of the reasons why new businesses seldom take off as expected in existing businesses is that not enough management resources are allocated to new businesses. More significantly, the management practices of existing businesses are unconsciously brought into new businesses. New businesses are governed by different rationales, standards, rules, and evaluation criteria to existing businesses. Therefore, management needs to clearly separate new businesses from existing businesses and operate each according to different rules and standards.

7 Disruptive innovation: Shifting between performance and competitive dimensions

Technological development possesses an inertia guiding it toward ever higher performance. This may be attributed to the individual characteristics of the engineers themselves, who seek to develop something superior before others do, or to competition between companies to develop something ahead of competitors. Whatever the reason, technological development and the resulting innovations will take the form of improvement with an insatiable desire for better performance. However, as Clayton Christensen's "The innovation dilemma" points out, performance improvements above a certain level lead to a shift in dimensions of performance, while shifts in the mainstream customer will lead to a shift in the mainstream competitive dimension.

Technology development is always a means to solve customer problems, not an end. However, sometimes technological development becomes self-directed, resulting in performance improvement gaining its own impetus. The problem is when the level of performance improvement achieved exceeds the satisfaction of the customer. If the customer's problem is solved in technical terms, they may pay more attention to different technical issues or be more interested in other issues besides technical ones, such as price or delivery time. At that time, the dimensions of competition will shift. Flat-panel TVs, which became commoditized due to a rapid decline in price once the trend toward higher pixel counts came to a halt, are an example of a rapid shift in the dimensions of performance to be promoted and in the dimensions of competition. It is worth noting that technological development can often overshoot the customer's satisfaction level by a large margin. This is something that companies that pride themselves on their ability to develop technology need to be aware of.

8 Reverse innovation: Where are the leading issues?

The basic assumption of previous explanatory models of innovation is that innovation is realized in developed countries and that developing countries subsequently enjoy the fruits of that innovation. These models assume a single direction pathway from developed countries to developing countries. However, the challenges that have emerged in developed countries are not necessarily the same as those that have emerged in developing countries. As such, new products and services created to solve problems in developed countries are not automatically accepted in developing countries. In turn, new products and services created to solve problems in developing countries will not be accepted by developed countries because of the backward nature of the problems they exist to solve. If this is the case, then developed and developing countries should focus on achieving innovation according to the different challenges they need to solve.

In *Reverse Innovation*, Govindarajan and Trimble emphasize that new products and services created to solve problems in developing countries sometimes contribute to solving potential problems in developed countries after the fact because of the advanced nature of the challenges faced by developing countries. Developing countries are not always backward in terms of the issues they face compared to developed countries. Depending on how the issues are set, developing countries may play an important role as a place to develop solutions that can be deployed in developed countries.

9 Openness and ecosystems: Competing and co-creating with others

In technology development strategy, the platform strategy (Gawer and Cusumano, 2002), openness of R&D (Chesbrough, 2003), and perspective of considering one's product/service development strategy within an ecosystem (Iansiti and Levien, 2004) are more important than ever. Unlike classical technological strategies that position the development of a single product or service as a stand-alone development, a platform-conscious technological strategy positions each product as part of a series of product groups (i.e., generations) and attempts to create price and functional advantages by adding relevance and continuity between products. Rather than formulating and implementing a new technology strategy each time, it is an attempt to establish a sustainable competitive advantage by creating a platform offering a shared technological foundation and business space. Intel's development of the PCI bus is an example of this. This strategy is also a way to cope with rapid technological progress.

Open innovation strategy is another way to cope with rapid technological progress. As there are limits to what we can develop on our own, we need to work together with other partners and create value collaboratively. Japanese companies that have pursued vertically integrated business models may have a lot of room left to pursue open innovation strategies. However, a deep understanding of one's own strengths is required to successfully leverage the achievements of other companies. Therefore, we must recognize our closed core strengths more clearly than we do at present so as to achieve open innovation.

As reflected by the term “ecosystem,” these technology strategies require a perspective that facilitates simultaneous competition and co-creation with others. The rapid pace of technological progress means that our competitors are also our collaborators.

This paper is a summary of Chapter 3 of Hitotsubashi University’s Institute of Innovation Research (2017), please refer to this book for further detail.

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