Chapter 6

TECHNOLOGY AND COMMERCIALIZATION STRATEGIES

Chapter Contents:

6.1 Chapter outline

This chapter will deal with the commercialization of new technologies in Japan as seen at the national level, the corporate level, and the level of individual product businesses. Various strategies and common features for technology exploitation will be elaborated upon to provide a broader context for subsequent chapters, which will deal specifically with IP strategies and IP management.

6.2 Technology policy and macro factors

There is an old saying, that stated roughly says Europe makes science, the USA innovates and Japan commercializes. This is obviously a sweeping statement, which is no longer true, but to a certain extent it has been true in the past. Europe has been providing an essential scientific base for the spur of US technological innovations from the late 19th century on, and the USA in turn has been providing much of the technological base for Japan's commercial achievements after World War II. Scholars have also pointed to the numerous innovative skills in the USA coupled with a certain lack of imitative and commercialization skills compared to Japan (see e.g. Mowery and Rosenberg 1989, Rosenberg and Steinmueller 1988). A number of reasons behind Japan's skills in commercializing new technologies can be found at the macro and policy levels.[1] For example, a strong pragmatic technology orientation in government and industry, a low level of government spending on military R&D, a high level of privately financed industrial R&D under conducive macro policies (e.g.

[1] An attempt to understand Japan's techno-economic success (although punctuated by recessions) must take into account a broad range of factors pertaining to Japan as well as to the countries with which she competes and cooperates, especially the USA (cf. Chapter 5). All the efforts by scholars, policy analysts, politicians, consultants, managers, investors, journalists etc. to explain Japan's industrial success and dominance in many sectors are almost an industry in itself (perhaps dominated by foreigners). That ”industry” will not be entered here, except for reminding about a few commonly voiced explanatory factors. Although the kind of macro-success Japan has enjoyed in the current period of history probably can best be understood as a result of a dynamic process with a multitude of factors interacting in complex ways over time, longer lists of explanatory factors do not necessarily add progressively to an understanding. Classifying factors, e.g. into categories as macro and micro level factors as done here, is also difficult and is an approximation at best. Keeping all such reservations in mind, technology nevertheless appears to have been a decisive factor in Japan's successful post-war development.

technology, fiscal and trade policies providing e.g. low cost of capital and instrumental protectionism) and fierce domestic competition have created a technology-driven economy with a strong market orientation.

The process of catching up generates dynamic advantages relative to the process of sustaining a lead (see Abramowitz 1986). Table 6.1 gives an overview of the pros and cons for a country's industry when operating as an early or late mover in a market. Japan has certainly been able to develop late-mover advantages. The catch-up process has also created a culture and a momentum conducive to further progress, based on skills or competence cumulated in the catch-up process. These skills are also highly useful in the process of sustaining a lead as well, at least for a time. Important examples of such skills are the ones acquired in connection with patenting and the use of patent information, as will be seen in this and the following chapters. At the same time, attitudes and competencies acquired by innovators and early market leaders often seem to threaten the sustenance of their leading positions, e.g. through the NIH syndrome, which could be seen as part of a larger ”success breeds failure syndrome” common among innovators.[2] A successful catch-up also tends to build in risks associated with rapid but unbalanced growth, allowing progressive and backward parts to co-exist in the economy, possibly to the point where the backward parts become bottlenecks seriously limiting further aggregate growth.

Of course, it is also possible that some attitudes and competencies nurtured by a catch-up process are not conducive to reaching and sustaining an innovative position. One example is what can be called the FIB syndrome (”foreign is better”), which deters companies from venturing into a technological lead. To overcome this syndrome, MITI has played an important role through its collective R&D projects, such as the VLSI project. Much has been written about the importance of MITI in engineering these collective R&D projects in ”pre-competitive” stages as an instrument for catching up (see e.g. Fransman 1994, 1995, Sigurdson 1995, 1996). However, forging ahead in addition to catching up also requires overcoming the FIB syndrome and the setting of actual R&D targets for the purpose of taking a technological lead in a dynamic race. When MITI proposed such targets, there was a large

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[2] Success may sometimes breed success but this seems to be less common among innovators and early movers in the long run (see e.g. Utterback 1994 and Leonard-Barton 1995). However, cumulation of capabilities to sustain a lead is still a possibility.

degree of initial hesitation among Japanese companies who were sceptical that such targets could be met, creating responses such as ”IBM will always be ahead”.[3] Naturally, collective R&D with government support has been instrumental in smoothing financial risks, but in addition, MITI, along with some progressive companies and industrialists, has been instrumental in overcoming the FIB syndrome in more and more parts of Japanese industry.

For further readings about Japan’s economic and technology policies, see e.g. Calder (1993), Fransman (1994, 1995), Freeman (1986), Gerlach (1992), Johnson (1984), Johnson et al. (1989), Odagiri and Goto (1993), Okimoto (1989), Porter (1990), Sigurdson (1995, 1996), Tyson (1992).

[3]At the same time IBM accelerated its pace when observing Japanese initiatives and advances.

Table 6.1 Advantages and disadvantages of early and late movers on markets[1)]

Early mover	Late mover
Advantages:	
• Economies of scale and learning and increasing returns in general • Firstcomers have first crack at emerging technologies and markets and the opportunity to establish unchallenged, dominant market share • Possibility to use pre-emptive and foreclosing strategies or otherwise build up barriers to entry • Reputational advantages • Possibility to build up exclusive IP positions • Possibility to set standards	• Economies of speed and timing • Reduction of basic R&D costs compared to firstcomers • Lower initial start-up costs • Reduction of aimless groping • Technological leapfrogging is possible • Learning from early movers • Reduction of NIH effects • Aggregate growth rates tend to be faster • Cumulation of catch-up competencies
Disadvantages:	
• Build-up of physical and intellectual capital which becomes obsolete • Build-up of inertia, rigidities and hubris • Build-up of the NIH syndrome and the success breeds failure syndrome	• Lag in technology • Resource scarcity due to early mover preemption • Forced to concentrate on low value-added products • Lacking economies of scale in production • Threat by foreign imports from firstcomers • Competition from foreign subsidiaries operating in home markets • Threat of being overwhelmed (the FIB syndrome) • Lack of large companies which can invest in product improvements, appropriate innovations and pursue second-to-market strategies • Tendency towards unbalanced growth and a polarized economy

Note:

1) In principle, categories diagonal to each other in the table would be logical negations of each other if the table had contained exhaustive lists of relative advantages and disadvantages. However, as a matter of emphasis the table shows mainly different factors in all four early/late pro/con categories without being exhaustive.

Source: Compiled and selected from Abramowitz (1986), Ames and Rosenberg (1963), Conrad (1984), Gerschenkron (1962), Kerin et al. (1993), Leonard-Barton (1995), Lieberman and Montgomery (1988), Okimoto (1982), Schnaars (1994), Utterback (1994) and the author. The works represent a mixture of country and company perspectives.

6.3 Technology management in Japan

A number of reasons behind Japan's success in commercializing new technologies can also be found at micro levels and in the fine structure of society and corporate life. A particularly important factor is the management skill developed in large parts of industry, especially for managing large corporations.[4] Since technology has been the engine of Japan's developments, skilful technology management has been crucial. As is well known, Japanese management has drawn considerably upon Western management but has at the same time developed unique features and a considerable range of managerial innovations (TQM, JIT, Kanban etc.), which in turn has been emulated in the West.[5]

There are several good writings available in English on Japanese technology management and related matters. See e.g. Branscomb and Kodama (1993), Bowonder and Miyake (1993), Eto (1993), Florida and Kenney (1992), Fransman (1995), Funk (1993), Imai (1986), Kodama (1995), Miyazaki (1995), Nonaka (1990), Nonaka and Kenney (1991), Okimoto and Nishi (1994), Sigurdson (1996), Urabe et al. (1988), Yamaji (1997), Woronoff (1992).

What then characterizes Japanese technology management? According to Westney (1993, p. 37), commonly recognized characteristics of the technology behaviour of Japanese firms, compared to US firms, are as follows:

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[4] It should be remembered that Japan's economic growth and catch-up have been partial and unbalanced between sectors (although with considerable equity in society at large), sustaining a divided economy, with several still backward sectors. (For further readings about large corporations and their management, see e.g. Aoki 1988, Aoki and Rosenberg (1987), Aoki and Dore 1994, Fruin 1992, Miyazaki1995.)

[5] This, by the way, illustrates two things. First, how innovation and imitation processes occur in management just as in technology. Second, how the roles of innovators and imitators may shift back and forth over time among actors (countries, companies, individuals), thereby inducing them to play a mixture of innovator/imitator roles over time in intertwined processes of catching up, forging ahead, falling behind, recatching up, etc. (to use the terminology in Abramovitz 1986).

1. Shorter development times
2. More effective identification and acquisition of external technology, on a global scale
3. More effective design for manufacturability
4. More incremental product and process improvement
5. Innovation dominated by large rather than small firms
6. Greater propensity for competitive matching of products and processes
7. Greater propensity for interfirm collaboration in developing technology
8. Greater propensity to patent
9. Weakness in science-based industries, for example, pharmaceuticals, chemicals, biotechnology

Several of these general characteristics have been corroborated in the present study, such as shorter development times, skills in acquiring external technology (including using interfirm collaboration), incremental and coordinated product/process improvements, high patenting propensity and skills, and the remaining weakness in certain science-based industries.

When specifically considering the commercialization of new technologies, or what we will also refer to as technology exploitation, a number of common features in Japan are indicated by the present study. These will be dealt with in Section 6.5.

6.4 Strategies for acquiring and exploiting new technologies

There are various means for a company wishing to acquire and commercialize new technologies and innovations. These means are mostly complementary and interact with varying importance over time in developing technology-based businesses. Simply to list and weigh these means through a snapshot survey is not sufficient for their understanding and application. In this study, survey data have therefore been complemented with extensive interviews. The survey data are first presented in Tables 6.2-7 below.

6.4.1 Technology acquisition

Tables 6.2 shows how Japanese corporations put emphasis on various strategies for acquiring technological capabilities. These strategies represent, in descending order, different levels of organizational integration from fully integrated in-house R&D to technology scanning (see Chapter 4).[6] External technology sourcing or acquisition by various strategies was found to be increasingly important, although in-house R&D definitely remained as the main strategy regardless of sector. Collaborative R&D and technology scanning was shown to be especially important on average. For a similar but smaller sample of Japanese large corporations, external technology sourcing increased during the 1980s (Granstrand et al. 1992b). To a considerable extent regarding Japan, external technology has traditionally come from foreign sources. Technology scanning has always had an international outlook, international technology licensing has had a long history and international joint ventures and other forms of cooperative R&D have grown rapidly in recent decades (Mowery 1992, Niosi 1994). Less is known, however, about how corporations view collaborations with universities at home and abroad.[7]

[6] The terms acquiring, building up and sourcing can be used interchangeably here. A common distinction is between internal and external sourcing, where internal refers to in-house and external refers to the various other sourcing strategies.

[7] For studies of industry-university collaborations, although without the international dimension, see Mansfield and Lee (1996) and Rosenberg and Nelson (1993). For a study of how corporations view their collaborations with local R&D organizations, including universities, see Pearce (1994).

Table 6.2. Strategies for acquisition of technological capabilities in large Japanese corporations[1, 2, 3]

(Scale: Of no importance = 0,1, 2, 3, 4 = of major importance.)

(Code) Question	Chemical (n=9)	Electrical (n=10)	Mechanical (n=5)	Total (n=24)
(C1) For your corporation as a whole, please indicate roughly the relative importance of the following strategies of building up your technological capabilities in 1987 and 1992:				
In-house R&D 1992	3.89	3.70	3.80	3.79
Growth ratio 1992/1987	0.97	0.98	0.95	0.97
Acquisition of innovative companies (or business units) 1992	1.88	1.40	2.40	1.78
Growth ratio 1992/1987	1.57	1.19	1.33	1.38
Joint venture and other forms of cooperative R&D, e.g. with subcontractors 1992	2.89	2.40	2.80	2.67
Growth ratio 1992/1987	1.26	1.42	1.07	1.27
Purchasing of licenses 1992	2.75	1.90	2.40	2.30
Growth ratio 1992/1987	1.13	1.04	1.10	1.09
Other forms of technology purchasing, e.g. contract R&D 1992	2.25	1.70	2.20	2.00
Growth ratio 1992/1987	1.06	1.13	1.10	1.10
University collaboration 1992	3.00	2.56	2.00	2.60
Growth ratio 1992/1987	1.26	1.23	1.25	1.25
University collaboration with universities in:				
Japan 1992	2.78	2.56	2.80	2.70
Growth ratio 1992/1987	1.04	1.11	1.20	1.10
USA 1992	3.13	2.67	3.20	2.95
Growth ratio 1992/1987	1.48	1.22	1.27	1.33
Technology scanning (incl. monitoring and intelligence) 1992	2.88	2.70	3.00	2.83
Growth ratio 1992/1987	1.04	1.00	1.17	1.05

Note:

1. The highest and lowest valued for each industry are overlined and underlined respectively.
2. Appendix D gives numbers by which the statistical significance of observed differences in the perceptual data can be approximately calculated.
3. The ‘growth ratio’ under each variable is the ratio between the value of the variable in 1992 and 1987.

As Table 6.2 shows, Japanese corporations put the importance of collaborations with US universities second only to in-house R&D, regardless of sector. Collaborations with their domestic universities during 1987–1992 have fallen behind US universities in importance, as perceived in 1992. Although this study only provides perceptual data in place of factual data on the foreign share of university collaborations in Japanese industry, it can be expected that this foreign share is quite high and will increase in the future.

6.4.2 Technology exploitation and complementary assets

New technologies can be commercialized in various ways, some of which are innovative in themselves, and some of which are commonly recognized and classifiable into various strategy taxonomies. Two such taxonomies for technology commercialization (or exploitation) will be used here, corresponding to Tables 6.3 and 6.4. The first taxonomy is based on contractual ways of linking a new technology to complementary assets inside or outside the company for production and marketing, typically of a new product (see also Chapter 4). The strategies are then arranged in falling order of organizational integration, from full integration through internal exploitation over various quasi-integrated forms to complete disintegration through divestment, i.e. selling the assets. (For details, see Granstrand et al. 1992. See also Teece 1987 for a related taxonomy.) Table 6.3 thus shows the preponderance across industries of internal exploitation, with no significant growth in importance attached to it between the years 1987 and 1992. Divestment is at the other extreme, dismissed across industries with little change between 1987 and 1992. The quasi-integrated intermediate strategies are employed fairly equally across industries and with growing importance attached to them, particularly in the mechanical industry for technology selling[8].

To create innovative firms is one way for a large company to package technology together with complementary resources or assets for production and marketing, usually under semi-autonomous management but with retained ownership and control. This may be an effective way of combining large and small company advantages in commercializing new

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[8] Technology selling is typically licensing out but also comprises selling contract R&D and engineering services.

technologies at some stage, especially for products and processes that fall outside the company's existing business areas.[9] This strategy can also be used for radically new technologies when the commercialization of which would be jeopardized by integration with some operating business division, entrenched in a current, well-proven technology. This strategy has not been used much by Japanese companies in the past, at least not for the purpose of potentially spinning off a new, innovative firm. However, the urge to become innovative prompts many Japanese companies to search for and experiment with new organizational forms. Another expression of this along similar lines is to endow the corporate R&D lab with responsibilities for the initial marketing of radically new products in certain situations, something that was tried in several companies with promising results.

It is also interesting to note in Table 6.3 that a significant and growing amount of a company's technology is not commercialized within reasonable time limits (especially in electrical companies), something that is also shown by the fraction of uncommercialized patents, as seen in Table 5.14. Uncommercialized technology results from a number of reasons: e.g. a time lag till commercialization, serendipities, a recent shift towards specialization, exploratory R&D or simply commercially unsuccessful R&D.[10] There is also a significant and growing amount of loss and leakage of proprietary technology. Both this and the amount of uncommercialized technology are in fact around the same magnitude as technology selling, although one should be very cautious when comparing assessments based on scales used across questions.

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[9] See Granstrand and Sjölander (1990) and Lindholm (1994) for details of this strategy.

[10] It is in the nature of R&D that only a portion of the R&D work is successful in the sense that inventions are made or technical specifications are met, and only a portion of technical success leads to commercial success in terms of market acceptance, and even then economic success in terms of total returns on investments is not guaranteed. For example, Mansfield et al. (1977), pp. 22-32, found that 43 per cent of the projects were not technically successful, and 35 per cent of technically successful projects were not commercialized, and 26 per cent of commercialized projects were not economically successful.

Table 6.3 Strategies for commercializing technological capabilities in large Japanese corporations[1)]

(Scale: No importance = 0, 1, 2, 3, 4 = Of major importance)

(Code) Question	Chemical (n = 9)	Electrical (n = 10)	Mechanical (n = 5)	Total (n = 24)
(C2) For your corporation as a whole, please indicate roughly the relative importance of the following strategies for commercializing your technological capabilities in 1987 and 1992:				
Internal exploitation 1992	3.89	3.50	4.00	3.75
Growth ratio 1991/1987	1.00	1.01	1.07	1.02
Creation of innovative firms 1992	2.00	2.00	2.40	2.09
Growth ratio 1991/1987	1.25	1.04	1.50	1.19
Joint ventures 1992	2.44	2.50	2.60	2.50
Growth ratio 1991/1987	1.40	1.33	1.40	1.37
Technology selling 1992	1.89	2.50	2.40	2.25
Growth ratio 1991/1987	1.24	1.43	1.90	1.46
Divestment 1992	<u>1.00</u>	<u>0.33</u>	<u>0.25</u>	<u>0.59</u>
Growth ratio 1991/1987	0.89	1.00	1.00	0.93
What is the magnitude in your company of:				
(C3a) Uncommercialized technology 1992	2.13	2.44	1.50	2.14
Growth ratio 1991/1987	1.27	1.33	1.17	1.28
(C3b) Loss and leakage of proprietary technology	2.29	2.56	2.33	2.42
Growth ratio 1991/1987	1.14	1.31	1.50	1.29

Note:

1) The highest and lowest values for each industry for question C2 are overlined and underlined respectively.

6.4.3 Internal exploitation

From a company's point of view the main function of a patent should be to help the company recover sufficient returns from its investment when commercializing a new technology.[11] However, there are other ways to perform this function, e.g. by means of secrecy, efficient production or efficient marketing. Mostly these other ways are complements rather than substitutes for using patents. Moreover, there are other advantages of a patent to a company, as well as disadvantages (see further Chapter 7). Thus, a company might apply for patents even if they are not important in commercializing new technologies, just as a company could refrain from patenting even if it is important. The questionnaire survey tried to assess the effectiveness of patents in fulfilling their main function relative alternative methods, as well as the advantage of patents in this respect relative to other advantages and disadvantages.[12]

Table 6.4 shows the survey results at country level, where the data for the USA are derived from Levin et al. (1987).[13]

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[11] There are several ways to express this function – capturing the returns from R&D, appropriating the benefits of innovation, protecting the competitive advantage of new or improved products and processes. No essential distinction between these expressions is made here.

[12] See Appendix B for a discussion on the questionnaire design and methodological issues.

[13] The US study used a scale from 1 to 7 so its data have been transformed to the scale 0 to 4 used here. The survey respondents in the US study were typically R&D managers, while the respondents in this study were typically IP managers, who were likely to put more emphasis on patents. Nevertheless, patents were not emphasized in the Swedish responses.

Table 6.4 Means for commercializing new product technologies

(Scale: No importance = 0,1,2,3,4 = Major importance)

Means	Japan[1)]	Sweden[1)]	US[2)]
(a) Taking out patents to deter imitators (or to collect royalties)	3.3	1.9	2.0
(b) Exercising secrecy	2.4	2.0	1.7
(c) Creating market lead times	2.7	2.4	2.9
(d) Creating production cost reductions	2.9	2.7	2.7
(e) Creating superior marketing	2.7	3.0	3.1
(f) Creating switching costs at user end	1.9	1.7	n.a.

Notes:

1) Current sample of 24 large corporations. Perceptions for 1992.

2) As reported in Levin et al. (1987). Perceptions for mid-1980s, rescaled to the scale used in the current study.

A few observations deserve to be pointed out:

1) Patenting ranked highest in Japan, while close to the bottom in Sweden and the USA, with the means of commercialization differing most among the countries.
2) Superior marketing ranked highest in Sweden and the USA, while Japan fell in the middle range.
3) Creating switching costs (”lock in” of customers) ranked lowest in both Japan and Sweden (data missing for the USA), and thus to ”lock out” competitors from the market through patents and other means was perceived as more important.
4) Sweden and the USA were fairly similar in their average responses, while Japan deviated most.

Thus, the data indicate a difference between Japanese and Western companies, in particular regarding the role of patents.

Table 6.5, shows a breakdown of industrial sectors in Japan. One may observe that:

1) Patenting ranked highest for both products and processes in chemical and electrical companies, with secrecy close to the bottom.
2) Mechanical companies deviated from the chemical and electrical firms for both products and processes, with the highest emphasis on production cost reductions and production process secrecy.

The country and sector differences challenge some notions commonly held, at least in the past. One is that patents play a secondary role overall compared to marketing and production efforts. This is certainly not true for Japan.[14] Another common notion is that secrecy plays a larger role than patenting in the protection of process technology. This is not true for Japan either, except for mechanical companies.

[14] Probable reasons for this are discussed in Chapter 9.

Table 6.5 Means for commercializing new product and process technologies in large Japanese corporations in 1992[1)]

(Scale: No importance = 0, 1, 2, 3, 4 = Of major importance; Tend = Tendency 1987–1992: Decreasing = -1, 0, +1 = Increasing)

(Code) Question	Chemical (n=9) Tend.	Electrical (n=10) Tend.	Mechanical (n=5) Tend.	Total (n=24) Tend.
(F6) How important to your company are on an average the following means for commercializing new product technologies?				
Taking out patents to deter imitators	$\overline{3.89}$ (0.5)	$\overline{3.40}$ (0.6)	2.60 (0.6)	$\overline{3.42}$ (0.6)
Exercising secrecy	2.38 (-0.1)	$\underline{2.50}$ (0.3)	2.40 (0.8)	2.43 (0.3)
Creating production market lead times	3.00 (0.2)	3.00 (0.3)	2.40 (0.4)	2.87 (0.3)
Creating production cost reductions	3.13 (0.3)	3.00 (0.4)	$\overline{3.40}$ (0.4)	3.13 (0.4)
Creating superior marketing and after-sales service	2.75 (0.3)	3.11 (0.6)	2.80 (0.4)	2.91 (0.4)
Creating switching costs[2)]	$\underline{2.13}$ (0.1)	2.75 (0.3)	$\underline{2.00}$ (0.2)	$\underline{2.33}$ (0.2)
(F7) How important to your company are on an average the following means for commercializing new production process technologies?				
Taking out patents to deter imitators	$\overline{3.33}$ (0.1)	$\overline{3.30}$ (0.4)	$\underline{2.40}$ (0.6)	$\overline{3.13}$ (0.4)
Exercising secrecy	$\underline{2.67}$ (0.1)	$\underline{2.60}$ (0.2)	$\overline{2.80}$ (0.6)	$\underline{2.67}$ (0.3)
Making implementation rapid	3.00 (0.2)	2.70 (0.2)	2.60 (0.6)	2.78 (0.3)

Notes:

1) Highest and lowest values for each industry are overlined and underlined respectively.

2) That is, costs for a customer to switch to another supplier.

Exercising secrecy

There may be a changing role regarding secrecy in the chemical and electrical companies in general, due to technological changes facilitating reverse engineering. For example, new types of chemical analysis can trace minuscule amounts of a wide range of substances in a product, from which the production process can be inferred. This not only helps competitors to reverse engineer, but it also helps patent holders to detect infringement through reverse-engineering of the suspicious products of their competitors. Thus, a weakening of secrecy protection by more cost-effective tools for reverse engineering increases the propensity for patenting (everything else being equal) in two ways: First, the innovator's secrecy barrier is more easily penetrated by imitators. Second, the imitator's secrecy barrier is more easily penetrated by the innovator's ability to detect infringement. This also holds true if secrecy protection is generally weakened for other reasons, e.g. outsourcing of process equipment and process engineering services to leaky suppliers, although the incurred savings in intelligence operations may differ substantially among competing companies. Chapter 7 further discusses secrecy protection and secrecy penetration.

The changing role of secrecy protection is further illustrated by Table 6.6. Although some new technologies make it easier to overcome secrecy barriers, such barriers on the other hand might become easier to erect as products and processes become more complex and multi-technological in character. For this and other reasons, complexity would raise imitation costs, making patents relatively less useful. However, this is not the case but rather the contrary as Table 6.6 indicates.[15]

Patenting

Numerous studies have confirmed the prevalence of differences among industries in their amenability towards patenting as well as the leading role of chemical and especially drug companies in patenting.[16] The issue of how the patent system relates to, or ought to relate to,

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[15] Question F4 in Table 6.6 is similar to question F6 in Table 6.5 and was included also for checking sensitivity of results. As seen, variations in observations occur when some means are excluded, but the main conclusions remain much the same.

[16] See e.g. Levin et al. (1987), Mansfield (1986), Taylor and Silberston (1973).

the intrinsic features of different technologies and industries is complex.[17] Many pending questions cannot be dealt with here, except for a few aspects. As science and technology evolves, codes develop, e.g. mathematical or chemical formulas, models, drawings and circuit schemes. A patent system puts certain requirements on the codification of an invention and its functionalities. Since, in different fields and stages of technological development, different codes are developed, one might expect differences in the way these codes meet the coding requirements of the patent system among technological fields. Moreover, there is reason to believe that these differences among technological fields are in the nature of nature so to speak, and that the differences may change over time. In fact, much of the essence of R&D is to make new discoveries, for which a descriptive language often is initially rudimentary, thus requiring an advance in the codification of new knowledge into operational language and symbolism. Chemical formulas constitute a type of structural, discrete code for describing matter that often enable fairly precise and pre-emptive linking of patent claims to discrete functionalities and performance. This does not preclude the possibility that codes develop (e.g. in electronics) that are similarly amenable to patent requirements and pre-emptive patenting. Also, patent applicants and examiners adopt and develop new codes and practices over time. After all, the patent system existed long before the current symbolism in chemical formulas or electronic circuit schemes. This is to say that some (but not all) industry differences in the appreciation of patenting pertain to the exogenous and changing nature of the technologies involved.

Creating competitive advantages

Finally, the importance of competitor lock-out relative to customer lock-in, when commercializing new technologies, should be recognized in the table data. In fact, one can talk about four ways of commercializing new technologies in everyday terms: to create a temporary monopoly or dominant position through run-in (first on the market); lock-in of customers (by raising their costs of switching suppliers); lock-out of potential competitors (deterring or preventing them from imitating by raising their costs of imitation); or squeeze-

[17] There are many significant differences between chemical, electrical and mechanical engineering corporations in Japan, a point that has been emphasized in the interviews.

out of existing competitors (by superior production or marketing and also by non-conventional as well as illegal methods such as bribing and threatening). These ways may be used together but with different emphasis in different stages of commercialization. They all aim at reducing competition or creating competitive advantage up to the point of creating a monopolistic position.[18] Needless to say, commercial success does not necessarily entail economic success in terms of sufficient total rate of return on the relevant investments.

[18] Note that being first on the market means having a monopolistic position during market lead time.

Table 6.6 Means for protecting new product technologies from being copied as perceived by large Japanese corporations[1)]

(Scale: Not effective = 0, 1, 2, 3, 4 = Very effective;
Tend = Tendency 1987-1992: Decreasing = -1,0,+1 = Increasing)

(Code) Question	Chemical (n=9) Tend.	Electrical (n=10) Tend.	Mechanical (n=5) Tend.	Total (n=24) Tend.
(F4) For your company on an average, how effective is each of the following means in preventing or deterring competitors from copying your new product technologies?				
Patents	$\overline{3.44}$ (0.9)	$\overline{3.70}$ (0.8)	$\overline{3.60}$ (0.8)	$\overline{3.58}$ (0.8)
Secrecy	2.44 (0.3)	2.70 (0.4)	1.80 (0.6)	2.42 (0.4)
Complexity of product design making copying very costly	$\underline{1.67}$ (-0.1)	$\underline{1.78}$ (-0.2)	$\underline{1.40}$ (0.2)	$\underline{1.65}$ (-0.1)
Lead-time advantages of the innovator making attempts at copying unprofitable	2.00 (0.1)	2.00 (0.1)	2.00 (0.2)	2.00 (0.1)

Note:

1) The highest and lowest values for each industry are overlined and underlined respectively.

In view of the primary importance attached to patents in Japan as means of profiting from innovation through protection, it is interesting to look at conditions limiting their effectiveness as well as conditions limiting the possibility of profiting from innovation in general. As for the latter, Table 6.7 shows that most of the limitations to profit from innovation apply on average across industries without significant differences.[19] On the whole it appears that mechanical companies are the least restrained in profiting from innovation. Lack of suppliers is least limiting in every industry, while conditions pertaining to technology acquisition, production and marketing were most limiting and more limiting than competition from imitators. This must be kept in mind when discussing the role of patents, a main function of which is to enable the innovator to reduce the competitive pressure upon himself during commercialization. The difficulties encountered in marketing innovations rank very high, which is perhaps not surprising, considering that many Japanese corporations have fairly recently moved from a catch-up stage to a more innovative stage.

Limitations of patents

A few limitations to profit from innovation could be alleviated by patents. Patents could be used directly to prevent copying, which is their main purpose, but could also be used indirectly to get access to technology needed through cross-licensing (see further Chapter 7). It is therefore of interest to find out about the limitations of patents in turn. Table 6.8 shows that in every industry the main limitation of patents is their inability to prevent the competition from finding ways to get around a patented invention by finding a substitute invention, i.e. to invent around.

Another major limitation of patents, which applies fairly equally across industries, is their limited functionality in a world of fast-moving technology. With more fast-moving patent offices as well, this limitation is partially negated. Other limitations differ more from industry to industry. Since most of these limitations are influenced by policy decisions, this observation could to some extent be used to support more industry-specific policies regarding the patent system. This is also in line with the findings and arguments by Levin et al. (1987).

[19] Note that Appendix D gives numbers by which the statistical significance of observed differences in the perceptual data can be calculated approximately.

The deviation regarding the mechanical companies' perceptions of limitations should again be noted.

One should also note that the limitations of patents in Table 6.8 are, on the whole, perceived as less severe than the limitations to profit from innovation in Table 6.7. However, one has to be careful in comparing averages of responses across tables. One can further note that the inability to prevent copying is perceived (in Table 6.7) about as equally severe as the corresponding limitation of patents to prevent invent-around (in Table 6.8). As mentioned, patents are particularly aimed at reducing the limitation to profit from innovation that arises from copying.

To prevent or aggravate inventing-around through the broad scope of a patent therefore becomes critical. This in turn speaks in favour of using patenting strategies such as blanketing and fencing, strategies for which Japanese companies have become renown (see further Chapter 7).

Table 6.7 Limitations to profit from innovation (commercializing new technologies) in large Japanese corporations[1)]

(Scale: No importance = 0, 1, 2, 3, 4 = Of major importance; Tend = Tendency 1987–1992: Decreasing = -1, 0,+1 = Increasing)

(Code) Question	Chemical (n=9) Tend.	Electrical (n=10) Tend.	Mechanical (n=5) Tend.	Total (n=24) Tend.
(F3) To what extent does each of the following limit the ability of your company to profit from innovation?				
Inability to prevent other firms from copying the technology	2.75 (0.4)	2.50 (0.3)	$\overline{2.00}$ (0.4)	2.48 (0.3)
High cost or limited access to capital	2.50 (0.1)	2.14 (0.3)	1.80 (0.4)	2.20 (0.3)
High cost or limited access to technology needed	2.75 (0.3)	2.88 (0.4)	$\overline{2.00}$ (0.2)	$\overline{2.62}$ (0.3)
Lack of access to competent suppliers of needed equipment, or of specialized inputs	$\underline{2.00}$ (0.0)	$\underline{2.00}$ (0.3)	$\underline{1.20}$ (-0.2)	$\underline{1.80}$ (0.1)
Problems of getting a product into production in a timely way	2.38 (0.3)	$\overline{3.00}$ (0.5)	1.80 (0.6)	2.48 (0.4)
High costs or other difficulties in marketing	$\overline{3.13}$ (0.4)	2.38 (0.1)	$\overline{2.00}$ (0.4)	2.57 (0.3)

Note:

1) The highest and lowest values for each industry are overlined and underlined respectively.

Table 6.8 Limitations of patents for technology protection in large Japanese corporations[1)]

(Scale: Not true = 0,1,2,3,4 = Very true)

(Code) Question	Chemical (n=9)	Electrical (n=10)	Mechanical (n=5)	Total (n=24)
(F5) To what extent does each of the following statements apply in describing the limitations of patents as protection of your firm's technology?				
New products are not patentable	1.89	1.20	0.80	1.38
New processes are not patentable	1.88	1.60	0.80	1.52
Patents are probably not valid if contested	2.11	1.80	1.00	1.75
Firms do not try to enforce their patent rights	1.11	1.00	1.40	1.13
Competitors can legally circumvent patent rights or invent ways around them	2.44	2.80	2.40	2.58
Technological development is so rapid that patents become irrelevant	1.78	2.00	2.20	1.96
Patent proceedings require a firm to disclose too much of its information	1.78	2.00	1.00	1.71
Compulsory licensing can be imposed by court decisions or regulations	1.22	1.20	0.20	1.00
Firms engage in cross-licensing with competitors	2.00	2.56	1.20	2.04

Note:

1) The highest and lowest values for each industry are overlined and underlined respectively.

6.5 Common features of technology exploitation in Japan

At the company level, the interviews in the study suggest that the features in Table 6.9 are characteristic for the sample of Japanese companies in their commercialization (exploitation) of new technologies. Each of these features will be dealt with in the subsequent sections.

6.5.1 Synergetic[20] diversification

Japanese companies at large have long been engaged in product diversification processes, usually resulting in a considerable diversity of product businesses (see e.g. Kodama 1995; Granstrand et al. 1989, 1994). As is well known, many Western companies also engaged in product diversification as a strategy for balanced growth and risk dispersion, especially when this strategy came en vogue in the 1960s and 1970s in the USA. Product diversification in the West often resulted in economic failure, as in ITT, although there have been some striking successes too, as in General Electric.[21] As is also well known, diversification failures in the West have then resulted in a pendulum swing towards product specialization, under labels such as ”back to basics,” ”stick to the knitting,” ”do what you do best” etc.

[20] Cf. ‘related diversification’. ‘Synergetic’ is used here to emphasize that (positive) synergies are accomplished.

[21] There are several studies of the relation between product diversification and growth in the West, but with disappointing results, e.g. Montgomery (1994), Ravenscraft and Scherer (1987). See also Chapter 4.

Table 6.9 Common features of technology exploitation in Japan

1. Synergetic product/technology diversification (reaping economies of scale, scope and speed)

2. ”Speed to market” through
   - Exploratory R&D
   - Incremental development and learning
   - Concurrent engineering, coordination and communication
   - Sense of urgency (stimulated by domestic competition)
   - Global marketing

3. ”Speed to technology” through
   - Technology scanning
   - Will to explore and experiment (often early on and with patience)
   - Technology acquisition (e.g. from Western firms and universities and through internal and external technology supply and llicensing networks)
   - Large central R&D
   - Technology transfer and communication internally and externally

4. Dynamic application orientation and user cooperation

5. IP protection, licensing and monitoring

In contrast, Japanese companies have on average been successful in product diversification. They also engage, not in unrelated or conglomerate diversification as was often the case in the West, but in related diversification and especially in technology-related diversification. Most companies interviewed in this study and related studies judged that most of their successful diversifications have been ”technology-driven” (Canon, Toshiba, Hitachi, Teijin, Toray, Yamaha, Seiko, NEC etc.).[22]

As a rule, Japanese companies have diversified through internal development, while US companies have typically diversified through mergers and acquisitions. In Japanese companies, there is in fact an ever-ongoing evolutionary process of diversifying the technology base together with diversifying the product base of the company. This is a process comprising several sub-processes in parallel: refinement of existing technologies, refinement of existing products, technology diversification related to the company’s existing products, and finally product diversification related to the company’s existing technologies. The company’s existing technologies are refined at the same time as technologies new to the company, but possibly relevant to its existing product areas, are incorporated in the company by various means and are then tested and further improved upon. Ultimately, the new technologies may be incorporated in a new product or in an existing product area with increased performance-to-cost ratios or new functionalities for the customer. This product and its technologies, including its production technologies, are then further improved upon etc.

As in-house competence in new technologies is built up, a search for new applications of these technologies is initiated, which after some time – occasionally a considerable time – may result in a venture into a new product area. Thereby, the product base of the company is expanded but in a way that is related to the existing technologies in the company. This technology-related product diversification, in interaction with product-related technology diversification, takes advantage of economies of scale, since the same technology may be utilized in several products, possibly with an adaptation cost, which is sometimes considerable but more often is minor (see Chapter 4). It must be noted that these types of economies of scale derive from the commonly held fact that technical competence in an area

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[22] The issue of diversification has been covered in several studies by the author and his colleagues. A quantitative study by Oskarsson (1993) corroborates the interview findings.

is built up at a considerable fixed cost but with a low variable cost when applied over a number of applications. That is, as with any body of knowledge, the cost of technology is not very dependent upon the scale of its use. In addition adapting the technology to different applications further enhances competence, which usually gives some kind of learning revenue.

Thus, new technologies often become a shared input in the development and production of several products, and are thereby subjected to economies of scale. This is especially true for generic technologies by definition. (Note the indications in Chapter 5 that the possibilities to find generic technologies may have increased.) These technological economies of scale must be distinguished from traditional static and dynamic economies of scale in physical production, as well as from traditional economies of scale in R&D derived from surpassing critical thresholds in the size of labs, etc. Reaping these latter traditional types of economies of scale also plays a considerable role in commercialization of new technologies in Japanese companies, e.g. through creating a dominant market share and driving down the learning curve, as is fairly well known.

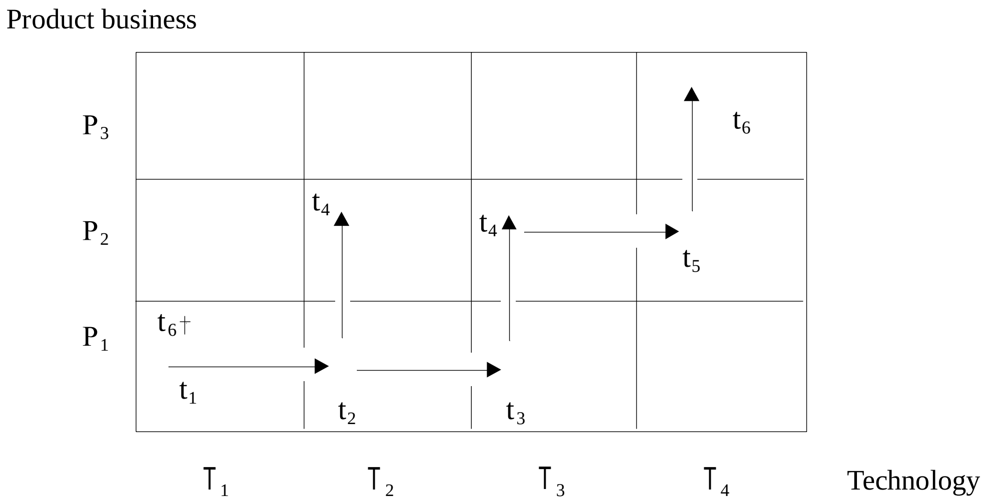
When new technologies are complementary to old ones in the technology base of a product – which they often are – technological economies of scope or technology related synergies arise from cross-fertilization. However, incorporating more technologies in a new product or process also leads to progressively increased R&D costs, since integrating more technologies requires more coordination and communication (see Chapter 4).

As also described in Chapters 4 and 5, new products and processes tend to become increasingly multi-technological. A diversified company with a broad technology base, which involves a new technology needed for a new product, also has what can be called speed advantages in addition to scale and scope advantages. The company can then incorporate this technology not only cheaper but also faster, by transferring it internally (possibly with some modification). Usually technology transfer is slower for a company which has to acquire the new technology through in-house R&D instead of external sourcing, although barriers to intra-firm technology transfer (such as NIH-barriers) may sometimes be significant. Hence, new proprietary technologies constitute intellectual capital with attractive economies of scale, scope and speed, which can be reaped through technology-based product diversification.

However, trademarks can also offer economies of scale, scope and speed, in connection with technology-based product diversification through the use of trademark extension and the building of combined corporate images and business images. This will be dealt with in Chapter 7.

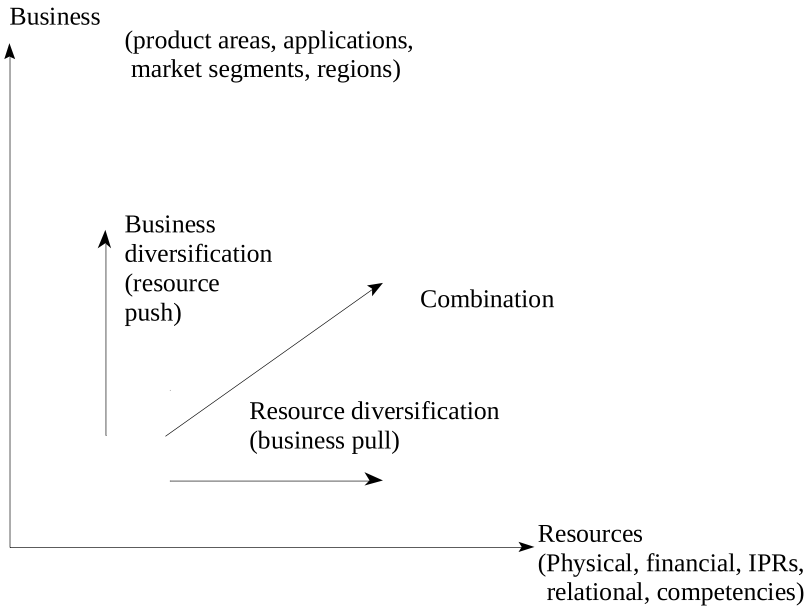
Figure 6.1 depicts the type of diversification processes just described. The corporate evolution could be seen in principle as stepwise over time (time points t_1 to t_6) although the steps may be more or less concurrent, and the combined technology/product base shifts over time, as may the customer base in concordance. The speed of technology diversification and product diversification differs between companies and industries. The figure shows a company that at time t_6 has left its historical origins completely. As described in chapter 4 this general kind of moving or ”floating diversification” is common for a raw material-based company or a chemical company over long periods of time, in which case physical by-products in extraction and processing also play an important role. Product invention-based companies in electrical and mechanical engineering, on the other hand, often display a kind of ”rooted” diversification, sticking to the original product business area, at least for a longer time, while diversifying into others. Of course, by speeding up the diversification process, e.g. with acquisitions, the time points t_1 to t_6 can be compressed, possibly yielding economies of speed. Figure 6.2 summarizes different diversification patterns in general.

Figure 6.1 Diversification processes utilizing technological economies of scale and scope



Legend
T = technology
P = product business
t = time
† = discontinuance (exit)

Figure 6.2 Different diversification patterns (paths) in general



In summary, there is interplay between market pull and technology push forces or more generally between business pull and resource push forces concerning diversification. Different mixes and sequences of these forces over time yield different patterns of input-output diversifications, e.g. ”first pull then push” or vice versa, or pull-push-pull, etc.

The Canon case is illustrative as an example of the diversification processes described; see Figures 6.3 and 6.4. Canon’s diversification move from camera business into copier business was actually without synergies and thus unrelated to existing technological and marketing capabilities. The diversification moves from copiers to laser printers to bubble jet printers on the other hand were technology and market related enough to provide significant economies of scale and scope, which also implied less risk. However, the success of these latter diversification moves was contingent upon the first, non-synergistic and more risky diversification.[23]

[23] In the words of Dr. Yamaji, CEO of Canon in 1992, diversification in the real meaning refers to this first type of diversification into technologies and markets completely new to the company, while ”derivative diversification” refers to related diversification.

Figure 6.3 Progress of Canon's diversification

(Source: Yamaji 1994)

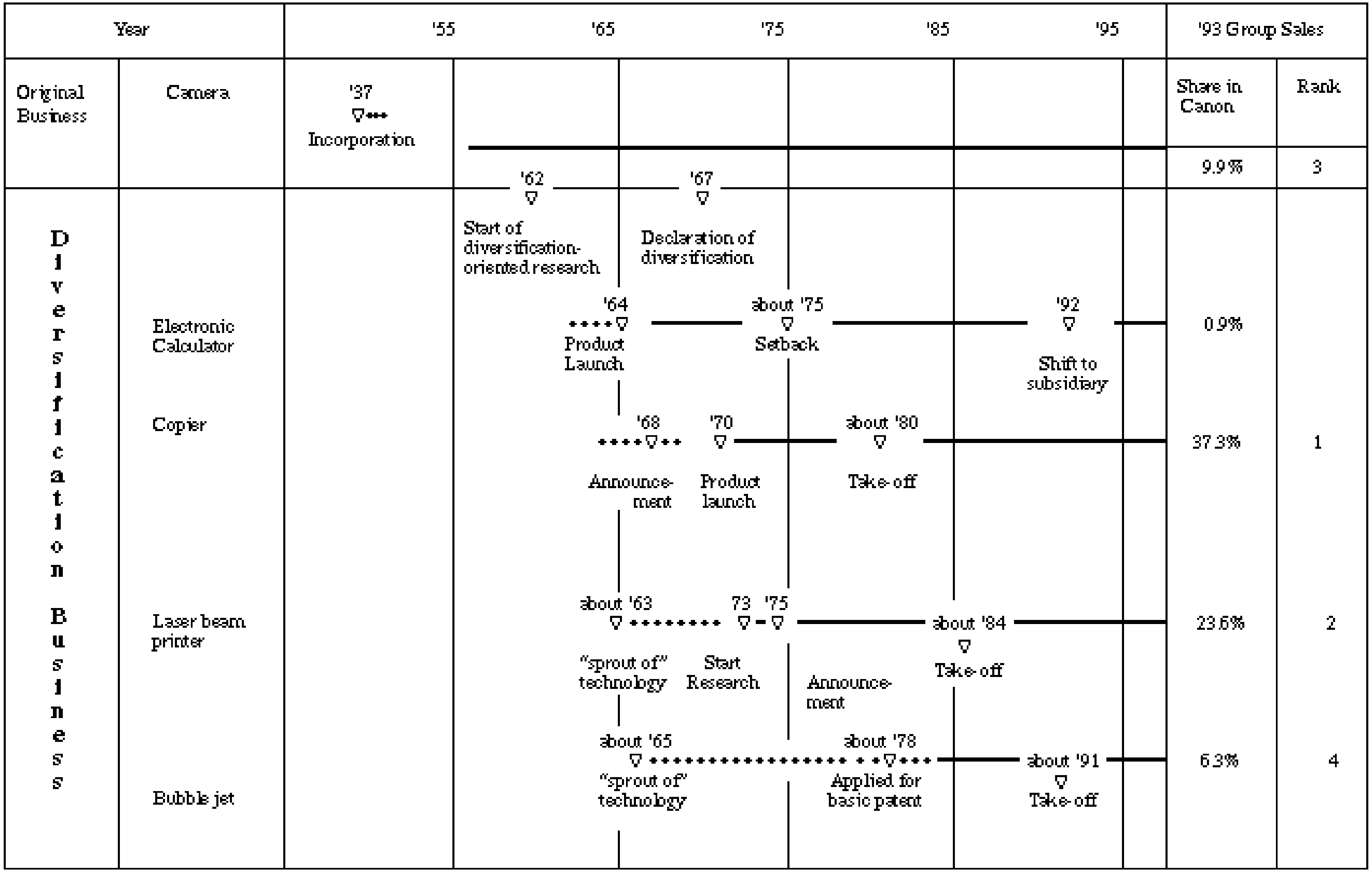
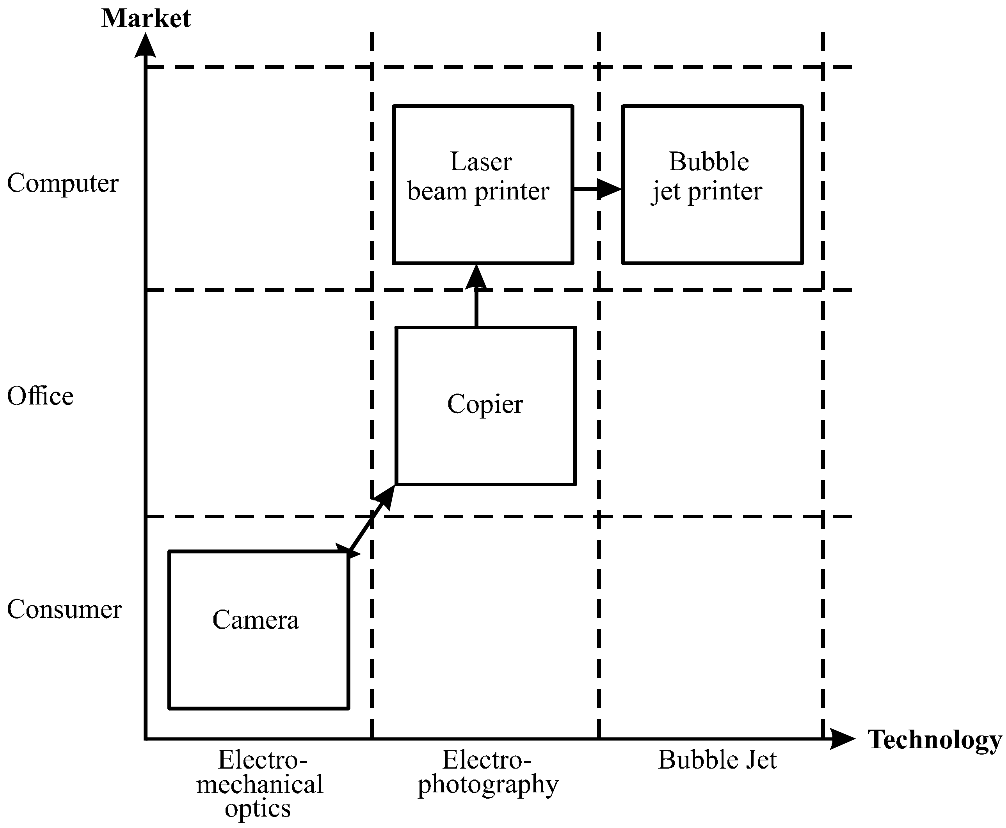


Figure 6.4 Technology-related product diversification in the Canon case

(Source: Yamaji 1994)



Several concepts and procedures observed in the studied corporations were created in connection with commercializing new technologies through diversification. For example, in Hitachi one talks about the need for two types of management: synergistic management and concurrent management. Concurrent management refers to managing various processes concurrently rather than sequentially. Concurrent engineering is a related concept, specifically referring to the considerable overlapping in time of the production and marketing preparations for a new product with R&D operations, (see further below).

A similar emphasis on synergy and speed is found in Canon. Canon has five major strategies (as of 1992):

1. New corporate philosophy of mutual prosperity (”kyosei”)
2. Strengthening of R&D
3. Diversification (which must be ”synergetic”)
4. Globalization
5. New organization

The special features of Canon’s R&D are in turn:

”1. Development of original products based on an unexplored technology for new business creation;

2. Revolutionize the organizational behaviour in the R&D division, particularly the improvement of R&D process management, R&D engineers and the organizational culture;

3. Continuous upgrading of core technologies to support new businesses;

4. Market-minded product planning to secure successive delivery to the marketplace of the best and long sellers as identified by strategic R&D planning.

Feedback from the marketplace is a continuous process in which virtually the entire organization, at all levels, is involved. To attain maximum efficiency in the management of

R&D processes, emphasis is given to time-saving in all aspects. This, ultimately, requires a persistent effort beginning with the individual in order to improve engineering skills. Canon's increased emphasis on efficiency in R&D, including bringing new innovative products to market in record time, accelerates the process of diversification and at the same time improves the usefulness of existing products." (Documentation provided by Canon in 1992.)

NEC uses the term trunk technologies, referring to technologies that give rise to many applications and product businesses (see also Branscomb and Kodama 1993). Other concepts related to technologies with such a potential for economies of scale and scope are wide application technologies, generic technologies, pervasive technologies and core technologies (see Miyazaki 1995, p. 23).[24]

Concepts related to technological economies of scope are: winning technology combinations (Canon), technology 'blocs' or 'families', technology fusion (Kodama 1995), technological convergence (Rosenberg 1994), technology confluence (Jantsch 1967) and also technology diversification.[25]

Some additional features in connection with technology and product diversification must be mentioned as well. First, diversification is often guided by a general vision, a well-known example being the C&C (Computers & Communication) vision of NEC. This is actually a technology-related business vision, directing attention to the technological convergence and the long-run complementarities among computer and telecommunication technologies for sustaining existing businesses as well as creating future businesses.[26]

Another example is Toshiba's E&E (energy and electronics), also a technology-related business vision. In fact, these types of corporate specific concepts and visions flourish in

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[24] In the economics literature, a recently coined term for such technologies is 'general purpose technologies'; see Bresnahan and Trajtenberg (1992).

[25] Strictly speaking the terms 'technology fusion', 'technology convergence' and 'technology confluence' refer to a process by which two or more technologies merge into a new kind of technology (e.g. mechanics and electronics merging into mechatronics), while technology diversification refers to the general process of broadening a technology base, thereby enabling economies of scope by combining technologies without necessarily considering a new combination of technologies as a new technology itself. Technological convergence in turn refers to a process by which two technology bases increasingly overlap, i.e. their technological distance decreases.

[26] Although a vision ought to be far-reaching into the future and have a long life, it cannot be a catch-all concept with an eternal life. Thus it can gradually become deceptive and direct attention away from complementarities with new technologies outside the originally envisioned ones.

Japanese business, often linked to some top managers as originators.[27] Within such a business vision, diversification may consciously proceed into intermediary product areas and from there to long-run target product areas. This intermediary diversification is primarily used for learning about technologies and markets, although cash may be generated as well for financing further diversification. A case in point is the multi-media area which is targeted by numerous companies, who attempt to enter this area at some entry point, building upon their specific resource strengths, and then penetrate the area through various diversification paths along which the resources could be further developed in stages. Moreover, the efforts in new technologies and product areas are often persevering, often formed with moderate resource levels, and occur in a corporate climate that permits repeated failures. This is in contrast to many Western companies, which often embark on grandiose programs with too little tolerance for failure, resulting in premature stoppages of what must, after all, be considered exploratory efforts in new technologies. (See e.g. Hayes and Abernathy 1980.)

Another important feature in this context is the continual small improvement of products and technologies in a step-by-step manner (”Kaizen”).[28] However the product variant proliferation is perceived by some companies as going too far and therefore uneconomical. New technologies are also often created through a particular breakthrough, which cannot be achieved through a series of small steps and then followed by several smaller improvements, which secures increasingly dependable and superior performance together with lower costs.

6.5.2 Economies of speed

Characteristic of technology exploitation is the well-known speed-to-market behaviour in the Japanese commercialization of new technologies, as illustrated above by Hitachi and Canon and shown in Table 6.9. Exploratory efforts in new technologies may start very early in industry, and proceed for many years in parallel in many Japanese companies operating in various product areas, but once their commercial feasibility is established, the final pace of

[27] For the use of visions as a management tool in Japanese business, see Fransman (1994).

[28] There is by now quite an amount of literature on this. An early book in English is Imai (1986), although perhaps somewhat overplaying the role of ”Kaizen” according to Branscomb and Kodama (1993).

commercialization is very rapid, spurred on by domestic competitors. To have R&D resources for basic technology development and exploratory work is therefore a prerequisite for reducing time-to-market in product development. Concurrent management and concurrent engineering with strong integration of simultaneous or overlapping, rather than sequential, activities for product development, production and marketing are then used for reducing time-to-market, as is well known.[29] Japanese firms also appear to be quicker than US firms to reach the market with new products, at least in case the products are largely based on external technology rather than in-house R&D.[30]

Concurrent management may further be applied not only to different functions in developing a new product, but also to the development of different product generations, whose development phases may overlap. That is, R&D for the second (or even third) generation is started before the first product generation is launched on the market. Of course, trade-offs must then be made between time and costs, and also between lost and gained sales through internal 'cannibalization' among the different product generations of the company. Moreover, customers may be lost entirely to the company if two generations are spaced too far apart in time, thus creating a need for an intermediate generation (or version or model) that serves as a ”gap-filler”, although it cannibalizes on the preceding generation.

As is also well known, Japan has in the past extensively acquired technology from abroad through various means, not least through licensing in, and used this technology for commercialization on the domestic market in the first place but also increasingly on international markets. As Japan has reached, and in a number of cases surpassed, the technological levels of the West, the possibilities of sourcing suitable technology from abroad have decreased.

This is a tendency that has been reinforced by an increased control of technology transfer to Japan by Western companies. Japan has also built up an impressive indigenous R&D as she tries to access technology increasingly through other means, such as joint

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[29] See e.g. Okimoto (1983), Chandler (1990), Nonaka (1990), Stalk and Hout (1990), and Cordero (1991).

[30] As shown in a study of about 200 Japanese and US firms by Mansfield (1988a, b). Actually, both innovation times and innovation costs were shown to be lower for Japanese firms, but not in case the new products were based on internal technology.

ventures, research cooperation and technology exchanges. In accessing new technologies in these ways, patenting plays an important role (see Chapter 7). Moreover, one source of technology, which is increasingly utilized by Japanese industry, is Western universities.[31] At the same time, Japanese R&D is becoming increasingly internationalized (see Chapter 5).

These patterns of behaviour also contribute to a kind of economies of speed, which arise from what can be called ”speed to technology”. This is actually a type of speed to input markets or factors, rather than speed to output markets, which is what is commonly meant by the phrase ”speed to market”. Speed to technology then contributes to speed to market.

In this context one can note that concurrent management may also be applied to the different phases of entering new business areas. However, the prevailing feature so far in Japanese companies is that technology-related product diversification has proceeded more stepwise in an evolutionary fashion, as described above (see e.g. Fig. 6.1). Thus, in the commercialization of new technologies there are races in several directions – speed to technology (input market) and speed to (output) market. The outcomes of these races determine market lead time. Patent races, in which the winner gets all, are part of these races, making ”speed to patent” important. In general there are multiple patent races in connection with developing and sustaining a new product, see Chapter 7. Speed to patent and speed to market and technology should then be seen as complementary races, rather than substitutes. Winning a strategic patent (see Chapter 7) is one very effective way to create substantial market lead time since such a patent not only slows down but blocks the competitors in their race to the market. Monitoring patenting activities of others is an important means for speed to technology. Sometimes in Western companies, patenting is seen as slowing down speed to market; in this case, insufficient patenting resources may be the actual impediment.

6.5.3 Dynamic application orientation and user cooperation

It is almost a truism to say that application and user orientation are key features of technology exploitation. Still there are some important points that are not self-evident, some of which are more specific to Japan.

[31] The questionnaire data in this study show this, although not tabulated here (see Granstrand 1998).

Weak science and research culture

First, Japan has had a weak science and research culture in the catch-up process, which has focused on technology – acquisition, adaption and deployment. Scarce resources for industrial R&D in the 1950s and 60s led industry to economize on dearly acquired technologies from abroad.[32] In fact, in S&T and R&D work, a strong and prestige-focused science and research culture often fosters counterproductive attitudes towards the commercialization of new technologies, with its need for less glamorous development and application engineering work. To build up a science and research base avoiding such attitudes is a current and future challenge for Japan, especially since a science culture can easily become stronger than the national and corporate cultures. It may then be useful to recognize that honoured features of science like creativity and pioneering are critical features in engineering as well. History of technology abounds with cases where creativity in applying existing technologies to new applications has made a big difference.

Application visions

Second, the application orientation is often dynamic or sequential in the sense that a series of applications can be envisioned as feasible over time, in contrast to a single application. Such a stepwise application vision can be developed through curious and persistent exploratory work and experimentation with new technologies already at an early stage. The different applications may correspond to different business areas as part of a stepwise (rather than concurrent) technology-related diversification as described above. The applications may also correspond to different market segments in the same business area, segments that require increasingly high technical performance. Usually, Japanese companies have climbed up the quality ladder, while several Western companies, at least in the military-industrial complex, have climbed down or ignored mass-market applications altogether. Kodama (1995), referring

[32] The policy in Japan at the time to acquire technology through licensing in rather than through joint ventures with foreign partners for the domestic market (although such ventures occurred as well) also put pressure on indigenous companies and their R&D personnel to learn how to exploit the acquired technology in all respects, without being able to resort to a joint venture partner.

to the Japanese approach of ”trickle-down”, describes this circumstance very well.

Broad market orientation

Application orientation is different from a narrow market orientation that only focuses on existing customers and their needs. Applications are characterized by physical attributes of a product or a technology in a certain usage context. Identifying those technical performance variables that give extra value added per R&D dollar to users in potentially large user groups gives guidance to R&D. A company that has maintained an innovative position for a long time thus has developed an R&D logic with preferences that have lost some of their economic relevance. For example, a company having developed centrifugal separators for years for applications in liquid food processing (milk, juice, etc.), oil purification etc., may have its R&D focused on the degree of separation as the primary technical performance variable, while for most users the reliability of separators in terms of its mean time between failures is the performance variable that primarily improves the user’s economy. Users often do not have this kind of knowledge either, and it may not be readily available or perhaps even given much thought.

User cooperation

This leads to the fourth point, which is the conduciveness of user cooperation to innovation. Such cooperation has generally increased, not only in Japan, and much has been written about it. An excellent work on the importance of user cooperation is von Hippel (1988).

6.5.4 IP protection, licensing and monitoring

As is evident both in the questionnaire responses (see Table 6.5) and in the case studies, IP protection, licensing and monitoring is an important feature of technology exploitation in Japan. This will, however, be dealt with in detail in the subsequent Chapters 7, 8 and 9.

6.6 Standardization and IPRs

In an increasing range of business areas, the setting of technical standards becomes highly important for commercializing new technologies, as technological interdependencies proliferate among products and services and compatibility among products and components imply significant benefits to consumers. Standardization and IP have both become recognized in recent decades as vital elements of business strategy. However, standard-setting and IPRs tend to create conflicts of interest, and these conflicts increase, depending upon how standards are set, as the value of IP and the value of compatibility of technical solutions increase. This has been the case especially in information technologies related to computers, telecom, audio/video etc. Licenses (including patent pools) offer a natural way of conflict resolution but can be difficult to negotiate and offer other problems as well.

Standards may be set informally as de facto standards ex post as a result of market dominance (compare the saying ”volume begets standards”) or they may be set by formal agreements ex ante (through consensus standards or planned standards) or by some combination of market forces and agreements at some stage of commercial development. In order for a company to get its proprietary technical solution accepted as a de facto standard, rapid buyer diffusion is important, which could be stimulated by low prices of products (penetration pricing). Imitation of the solution among other sellers is at least as important. Rapid seller diffusion could be stimulated by low prices of licenses or by giving everyone the right to use the technical solution in their products (i.e. to create an open standard). Alternatively, seller diffusion could be halted (e.g. by strong IPRs) so that the company’s proprietary technical solution becomes dominant. Thus IPRs could be used in several ways to advance de facto standard setting.

As the stakes in standard-setting are high and technology moves fast, there is a premium on early standard-setting (although premature standardization may jeopardize the further technical developments around the standard). Thus, standardization tends to be related to newer technologies as well as involving a deeper level of technical detail. Altogether these factors imply a growing volume of standards. This in turn leads to a closer interaction between standardization and the formation of IPRs and patents in particular. In general, IPRs tend to complicate ex ante standard setting. Standard blocking patents, i.e. patents that block a proposed or factual standard, become especially crucial. The value of such patents to patent holders could be tremendous, especially in the case of global standards. At the same time, a non-generous licensing policy by the patent holder could lead to the standard being abandoned. The classic case in point was the battle between the VHS and Betamax standards for VCRs starting in 1975, where JVC's generous licensing policy contributed to the VHS victory in the mid- to late 1980s, inflicting the largest business and morale loss to Sony in its history (see Granstrand 1984 and Grindley 1995). Since then, the strategic role of standards in commercializing new technologies has been astutely recognized in Japan, as elsewhere. In connection, the increasing importance of patents has also been recognized. A number of Japanese cases of standard-setting in connection with VCR, CD, DAT, ISDN, HDTV and DVD are described in Sigurdson (1996). See also reports from IIP, e.g. IIP (1995).[33] Here the European GSM system for mobile communications is given as an illustration of the problems with patents in standardsetting. The case also illustrates how patent disputes could change the patent culture in a whole industry. In particular, the GSM case triggered a turnaround in Ericsson regarding IP (see also Chapter 5).

In the early 1990s the GSM system involved over 2,000 patents, of which about thirty were standard blocking patents. However, patenting had traditionally been considered a secondary issue in the telecom industry, especially among the traditionally monopolized national telecom service providers. This held true also in the early developments of GSM in the early to mid-1980s. Few, if any, really imagined that someone from the outside could step in and disturb the cooperative and consensus-seeking standardization process by patenting an invention and refusing to license it on generous terms. This lax IPR mentality also applied to Ericsson as an equipment supplier, as well as to some other European telecom companies, in addition to the national service providers in Europe. A kind of club mentality had developed in the telecom community in Europe with a gentleman's agreement to be generous to each other when it came to patents. The public-good orientation among the monopolized telecom service operators, thriving on administratively sustained high price levels as they were, had penetrated the whole sector. To let a patent block a standard, for example, was considered unfair, if not mutiny, among traditional telecom companies.

The situation changed drastically in the late 1980s when Motorola, as a newcomer on

[33] There is also a growing literature on standards and IPRs in general, see e.g. Farrell (1989).

the European scene, started to use patents aggressively. It is easy to overly dramatize this, and it is difficult to find out what really happened amid all the accusations. European manufacturers said that they had had a license agreement with each other for the new digital cellular GSM standard. Discussions in standardization bodies were also conducted in an open atmosphere and ideas about standards and specifications exchanged without much concern about patents. Suddenly a company such as Ericsson found itself in a position where it could have possibly been forced to pay royalties to someone else for inventions Ericsson people thought they had originated. Moreover, Motorola could have blocked a GSM standard by its patents. Motorola could also have complied with the European claims to offer a license but only for Europe. Thus it could have achieved a strong monopoly outside Europe when the GSM standard was adopted elsewhere.

In this process Motorola got the image as the ”bad guy,” e.g. stealing ideas from the GSM work of others and patenting them and misusing its patent power in general. Motorola, on the other hand, claimed that it had a long track record of competing in the electronics industry, for which patenting was an integral part of doing business, and that the ”GSM group” recognized too late the serious nature of the pertinent IPR issues and specifically the Motorola patents.

All in all, the conduct of Motorola triggered a new era of heightened IPR awareness in telecommunications, leading to an irreversible track of new patenting and competitive behaviour in general, on which service providers have also embarked, pushed by privatization, liberalization, competition, internationalization and globalization in general. Motorola thereby illustrates the role of competition spurred through new entrants, so often observed in economic history.

In summary, the reasons behind the increasing importance of patents in standard-setting in the telecom industry since the 1980s are: (1) volatile collective agreements regarding standard blocking patents were challenged by aggressive patent holders, recognizing the tremendous commercial potential of patents in standard-setting; (2) standards became increasingly linked to new technologies and sub-technologies with patent protection possibilities; (3) the consumer electronics industry, with its competitive practices, became more involved in telecom, while competition intensified in general in the industry.

6.7 Summary and conclusions

Japan has rapidly and successfully developed into a technology-based state after World War II. Capabilities in acquiring and exploiting technology have evolved during Japan's catch-up process in a way that has found traditional innovative leaders in the West with strong S&T capabilities and S&T cultures falling behind.

This chapter has made a brief review of the pros and cons of being an early or late mover on the market, a review that can help explain the dynamics of the often observed phenomena of catching up, forging ahead and falling back and then perhaps coming back again. In its transition from a catch-up stage to a more innovative stage, Japan has had to contemplate these dynamics, that is, whether or not success ultimately tends to breed failure that can again produce conditions for success. The general challenge ahead is to make the transition from a technology-based state to a more balanced and sustainable intellectual capital based state.

The capabilities in managing technology and IP that have developed in Japan, especially in her large corporations, have some specific features, although they often build upon management concepts and techniques having originated in the West. Based on survey data and interviews the chapter has pointed out country differences as well as sector differences in various technology management strategies and IP management strategies. Access to technology as well as competition is a major limitation to profit from innovation as perceived by the Japanese corporations. Unlike European and US corporations, Japanese corporations considered patents as the most effective means of capturing the profits from innovation by restricting competition. The major limitation of patents as perceived was their inability to restrict competition from inventing around these patents. From society's point of view, patents should restrict competition but only up to a point where the dynamic efficiency from more innovations arising from strong patent protection balances against the static inefficiency from monopolistic pricing based on strong patents. Although difficult to assess, there seemed to be no sign of an unbalanced trade-off on average across industries. Patent laws could be tailored differently for different industries, taking into account that limitations to profit from innovation and limitations to patent differ across industries. However the general patent policy has always been to treat industries equally. Exceptions have occurred, such as in the pharmaceutical industry, where prolonged patent life times have been granted. Industry specific rates of subsequent innovations also effectively limit actual length of patent protection. The delineation of a permissible patent scope is moreover to some extent dependent upon industry specific practices.[34] Thus, there is already some room for tailoring patent protection for different industries. The policy issue how to tailor industry specific patent protection is very complex, however, not the least because of the many-to-many correspondence between technologies and industries as a result of generic technologies and multi-technology and multi-patent products and processes. Although benefits of tailoring could be demonstrated, the costs of tailoring may very well be prohibitive.

A number of specific features in Japanese strategies for exploiting technology were elaborated. One such feature, differing sharply from the West, was the propensity to engage in technology related product diversification in co-evolution with product related technology diversification, thereby benefiting from economies of scale, scope and speed. The case of Canon was given as an illustration. Speed to market and speed to technology were other important features, as were application diversification based on application visions and user cooperation. Emphasis on intellectual property management was a further important feature.

The chapter finally described how issues surrounding patents and standardization have become much more closely intertwined and altogether commercially important in recent decades.

[34] Regarding aspects of the scope of patents, see the already classic article by Merges and Nelson (1990) and also David (1993). In new technologies it is difficult to delineate a balanced scope, see e.g. Brandi-Dohrn (1994).