Chapter 9

ANALYSIS OF PATENT INFORMATION

Chapter contents:

9.1 Chapter outline

As part of the "patent deal" between inventors and society, inventors have to disclose information about their inventions in exchange for patent rights, as described in Chapter 3. This information should be sufficient to allow a skilled person or team to reproduce the particular invention (although that is not always the case in practice since patentees often try to minimize what they disclose in their patent applications.) A patent document thus represents value to prospective imitators, at least when the patent expires. In addition, patent information is also of value, and even more so, to inventors and firms performing related R&D, because it assists in their technical decision-making. Patent information also adds value to economic decision-making among a variety of other agents, e.g. policy makers. Thus, patent information may be helpful e.g. in avoiding some overinvestment of R&D in a particular field, pointing out technological trends, assisting in division and coordination of inventive labour, finding collaborators, etc. But some patent information may also have detrimental effects per se, besides the inherent distortive effects (such as monopolistic abuses, see Chapter 3) of patent rights themselves.

This chapter will describe how patent information is used and can be used. Since this topic is rich and rapidly expanding, this presentation cannot be comprehensive. Therefore, this chapter is intended to serve as a textbook introduction in much the same way as chapter 3 did on patent rights.

9.2 Use of patent information in general

9.2.1 Sources of technical information

Research methodology in economics and management has come a long way since Adam Smith and Frederick Taylor, and there is no reason to believe that this evolution will cease. New methods for collecting, analyzing and presenting data and information are being developed. Computers and telecommunications will expand the availability of empirical information and its amenability to analysis. Large amounts of information are already collected or collectable about patents, publications, personnel (human capital), products and pecuniary flows, pertaining to companies, R&D, products, production, trade etc. Some of these data sources have only recently begun to be exploited on a significant scale in economics and management aided by computers and statistical methods.[1] (For a sample of studies using patent and/or publication data, see Archibugi and Pianta (1992), Boitani and Ciciotti (1990), Brockhoff (1992), Cantwell (1995), Carpenter and Narin (1993), Chakrabarti

[1] Consultancy firms (such as Derwent and CHI) as well as patent offices have long since offered various patent information services and databases. There are numerous (hundreds or thousands) of databases with World Patent Index and Inpadoc being two traditionally important examples. World Patent Information is a central journal in this area.

(1989), Chakrabarti and Halperin (1990), Eaton and Kortum (1996), Ehrnberg (1996), Faust (1990), Glisman and Horn (1988), Granstrand et al. (1997), Griliches (1984), Grupp (1994), Hall et al. (1998), Jaffe (1989), Jaffe et al. (1993), Malerba and Orsenigo (1995, 1996), Mogee (1991), Pavitt (1985), Narin and Noma (1985), Narin et al. (1987,1992), Miyazaki (1995), Soete and Wyatt (1983) and Trajtenberg (1990).[2] For the use of detailed product line statistics see Scherer and Ross (1990, Chapter 17), and detailed educational statistics, see Jacobsson and Oskarsson (1995) and Jacobsson et al. (1996).

Some data sources have been under-exploited, e.g. the technical data about products and processes available in patents and publications as mentioned above. Some data sources are clearly deficient but they have been improving over time and are increasingly becoming internationally harmonized, e.g. the data about R&D and technology trade (licensing in/out) is collected according to OECD standards. At the same time, several data sources commonly used in economics, such as traditional industry and trade statistics, are increasingly losing their validity due to rapid technological changes, and the diversification and internationalization of companies across industrial and national borders.

Turning specifically to direct sources of technical information and knowledge, one may distinguish between four types of what can be called technical information carriers[3]:

1) Patents
2) Publications (i.e. S&T publications)
3) People (i.e. S&T professionals)
4) Products/processes (S&T artefacts)

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[2] For significant early works using patent statistics, see Tisell (1907, 1910) – regarded as pioneering by Merton (1938, p. 469) and Schmookler (1959, p. 123) – Griliches (1964), Schmookler (1950, 1966) and Scherer (1959). For good surveys of such studies, see Archibugi (1992), Basberg (1987), and Griliches (1990).

[3] A technical information carrier (or a technology carrier) is meant as an entity that carries technical information or knowledge, i.e. technology. Technology in products and professionals is sometimes called embodied technology, while patents and publications carry disembodied technology. Some people moreover distinguish between technical knowledge, being embodied, and technical information, being disembodied. The distinction between tacit knowledge and codified knowledge has also become common. Disembodied knowledge is then codified, but the converse is not necessarily true.

These technical information carriers could be used as indicators of technology-related resources and activities. However, the four types of technical information carriers have some similarities and dissimilarities, as well as relative advantages and disadvantages as indicators or detectors for different purposes (Table 9.1.) Needless to say, there are complementary sources of information, such as R&D, innovation, market and firm statistics.

In this context patent information, despite its many and well-recognized inadequacies, stands out as a unique source of technical information. More than any other source, it is collected, screened and published according to internationally agreed standards. It continually provides an assessment of the state of the art together with at least a rudimentary measure or metric of technological change. It thereby enables a transparent accumulation of knowledge on a global scale.

The inadequacies of patent information emanate from variations in companies' propensity to patent, classification errors, international differences in patent systems, patent office behaviour, and so on. In addition, reading as well as writing patent documents may be tedious and boring for the non-specialist. The latter point may be tackled by management through efforts in building a patent culture. (See Chapter 8 and the way top management in Canon has encouraged the reading of patent documents. See also Yamaji (1997).) Education and training in this respect is important. Company guidelines for reporting R&D results in internal publication series could moreover facilitate the adaptation of R&D reports to patent applications.[4] In addition, presentational techniques could often improve.

Patent information also serves many purposes and user groups, which calls for the need to customize it for the appropriate audience. Patent-oriented indicators for benchmarking raise the interest among business managers. Patent maps (see below) produced according to some internal standards are useful for various R&D decision-makers and business managers, while drawings and other details in patent applications are useful for R&D and design people.

[4] The patent claims in a patent application are usually difficult to write because of the legal aspects and the special language often required, and therefore also not easy to read, but the specifications in the patent documentation are similar in writing to any other technical documentation.

Table 9.1 Comparison of technical information carriers

Type of carrier	General nature	Universal classifications of technology areas	Metric of technology[1)]	Citation information[5)] available	Pros[9)]	Cons[9)]
1. Patents	Disembodied[2)] Public	IPC US [7)]	Simple accept/ /reject standard[10)]	Yes	Length (time span), breadth (range of technology areas), depth (amount of detail) of coverage Quality control Easy access Standardized Codified	Biased coverage Delayed Misclassifications (e.g. in new areas) Variability
2. Publications[8)]	Disembodied Partly public	LC UDK INSPEC etc.	No common standard	Yes, as a rule	Length, breadth, depth of coverage Partial quality control Partly accessible Codified	Biased coverage and content Delayed
3. Professionals	Embodied Private	Educational categories	Several levels and grades, partly standardized	No[6)]	Depth Timeliness Accessible Creative	Subjective bias Proprietary Partly tacit
4. Products	Embodied Partly public	No common one[3)]	Physical performance metric but not directly for information[4)]	No[6)]	Enables reverse engineering Objective Partly codified Precise measures of performance	Costly to access before market introduction

Notes:

1) That is measure of the size of an advancement in technical knowledge.

2) Disembodied means that the physical nature of the carrier is not relevant (e.g. paper, electronic storage) and that the information is completely codified and retrievable. Part of a professional's knowledge is tacit and products may not be fully possible to reverse-engineer.

3) Industry classifications (e.g. ISIC) could be used as proxies. Note that the concordance between product classes and patent classes is far from one to one (see e.g. Scherer (1982), who also suggests patent offices should provide industry codes as well.)

4) Indicators of hi-tech vs lo-tech (or hi/med/lo-tech) products exist, loosely referring to the amount of technical information in a product. The term 'technometrics' refers to the measuring of technical performance in physical terms.

5) Or genealogical or longitudinal information, that is, information about relations to previously appearing technology carriers in the category. Latitudinal information in the classification system (i.e. information about related classes in the form of multiple classifications) is sometimes available (e.g. for patents).

6) Genealogies could be constructed but are not readily available.

7) Many users consider the US patent classification system more technology-oriented than the IPC system.

8) Including all storage forms on physical substrates (papers, CD-ROM etc.). Patent publications are excluded since they are treated separately.

9) The assessments of pros and cons are only briefly indicated here. For more details see e.g. Archibugi (1992), Griliches (1990), and Pavitt (1985).

10) It should be noted that variations in practice in this standard might be substantial as the minimum level of invention required is difficult to specify in advance once and for all. In addition, different patent offices apply different standards. The standards may also vary over time, across technologies and also among patent examiners. The final validity of a patent is moreover decided in court if challenged. Finally, a patent granted to an invention only indicates that the invention meets the patenting criteria but is not a measure of how well these criteria have been met.

However valuable in itself patent information may be, it could, and mostly should as well, be fruitfully combined with information from other data sources including publications, seminars, informal contacts and so on. There are various complementary benefits to be reaped when combining patent information with other types of information, depending in turn on the purpose of the analysis, of course. This must be kept in mind when reading the following sections, which primarily deals with patent information.

9.2.2 Application areas of patent analysis

It is important to delineate what patent information actually comprises. There are several primary sources of patent information.

Patent documents

The main component of patent information is that provided in written form in the publicly available documents that have formed the basis for the decision to grant a patent to the patent holder. The patent document contains various items, such as application and issue date, name and location of inventors and assignee, title, abstract, claims, description, patent classification, references to other patents, and priority information.[5]

Auxiliary documents

There are various auxiliary documents and information items produced during the patent application processing procedures, most of which are publicly accessible.[6] The content and nature of these information items vary a great deal from case to case, since they derive from varying, less standardized procedures such as state-of-the-art search reports, opposition and invalidation claims, appeals etc.

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[5] For details, the reader is referred to actual patent application forms (which vary across countries, although with many common elements).

[6] Getting access to some of these documents may be difficult, however, for example getting access to so-called interference case records in the US for assessing who has priority to an invention under the "first-to-invent" rule in the USA. (See e.g. Kingston 1995, who proposes using interference procedures as a model for resolving IPR disputes.).

Proprietary information

There is proprietary information related to a patent application both on the patent applicant side (i.e. the related R&D information) and among third parties, e.g. companies opposing a patent application or attempting to invalidate a patent.

Licensing information

There is information about licensing of patent rights; information that is usually proprietary and seldom disclosed by the parties involved.

Maintenance information

There is information about the maintenance of patent rights including when these rights were dropped by patentees due to non-payment of the maintenance fees to the patent office.

All these different types and sources of patent information then provide selected inputs to various public and private patent data bases, mostly computerized and mostly obtainable at a cost (which can be substantial).[7]

Thus patent information is a multi-faceted concept. Below, we will use it in the narrow sense of the standard patent information basically provided by the patent application documents. Such aggregated patent information can in general be used as both technological and economic indicators. More specifically, patent information can be used to indicate:

1) Company's and competitor's technological profile, strength and positions in various technologies and markets as indicated by patent profile, volume, shares, breadth, maturity, patent portfolio composition, citations etc.[8] This is useful for company

[7] There are several public and commercial data base services, provided by Derwent, JAPIO, Inpadoc, Lexis, Westlaw, etc.

[8] These concepts are made precise and operationalized in various ways in applications. For examples, see Narin et al (1984) and Battelle (1995) for early works and various other works. See e.g. Narin at al (1992), Brockhoff (1992) and Mogee (1993) for applications at company level, which is of primary importance here. For applications primarily at the S&T policy level, see e.g. Archibugi and Pianta (1992), Grupp (1991), Van Raan (1988), and Sigurdson (1990)

benchmarking as well as for identifying strategic groups of companies with similar patent strategies or new entrants or technological actors in general.

2) Technological conditions and changes in general such as technological trends, fluctuations, distances, convergence, genericness, interdependencies, family (cluster, system, bloc) formation, entries, exits, transitions, concentration, maturity, ageing of technology base, diminishing returns, spill-overs, linkages to other technologies and sciences, etc. as well as more specific technological conditions such as fertile R&D directions, likely strategic patent positions, infringement risks, shifts from product to process R&D, and revival of old technical ideas.

3) R&D growth, productivity, fluctuations, and concentration of inventive activities as indicated by patent counts, patents per R&D dollar, or per employee citations, etc.

4) Suitable targets for technology acquisition through company acquisitions, mergers, joint ventures, R&D cooperation, licensing, hire-overs of key inventors, etc.

5) R&D and technology investment strategies.

6) International marketing strategies.

7) Valuation of a company's technology assets.

8) Opportunities for cross licensing.

9) Technological strength, positions and actors of countries or regions, e.g. for aiding actor identification or locational decisions regarding R&D and/or production.[9]

10) Fluctuations related to business cycles, investments, economic growth and aggregate S&T growth as well as patent office resources.[10]

11) History of technology and economic history.

Table 9.2 gives a more detailed overview of the useful patent information items for some of the more important applications above. The use in regular R&D work of the technical

[9] For example, in the USA, the Bay Area with Silicon Valley ranked highest in the mid-1990s in terms of patents per capita.

[10] See Griliches (1990) for an excellent overview.

information given in the patent claims and the invention description in general should finally be recognized as the major application of patent information (item 6 in Table 9.2).[11] Some (fairly simple) illustrations of benchmarking using patent information are also presented in Appendix B.

[11] This traditional application can witness new developments as patent information becomes computerized and can be subjected to various types of content analysis. The potential in this area is illustrated by the scheme developed by the Russian patent engineer G. Altschuller who claims that there are a number of principles of invention that could be detected by analyzing patent information. Certainly expert systems based on computerized patent information could be expected to become widespread, valuable tools in technical problem solving. It is even conceivable that a computer would be able to generate a new patentable invention.

Table 9.2 Patent information for technology and competitor analysis

	Analysis application	Useful patent information items
1.	Analysis of competitors' technology (benchmarking)	Patent class codes (main and side class code) and year of application for competitors give their patenting profile, patent positions (patent application shares), R&D directions, and entry/exit pattern in different technologies
2.	Technology breakthroughs, shifts, trends and forecasting	Patent counts over time in different patent classes for absolute and relative growth trends. Multiple classifications for e.g. technology fusion and technology diversification. Patent citation data for weighing technological importance and age of technology base.
3.	International market analysis	Patent country codes and country coverage of patent families of competitors
4.	Valuation of technology assets [2)]	Patent volume and patent shares, patent citations, patent renewal fees, patent vintage structure
5.	Tracking and monitoring of key inventors/actors	Inventor/actor name, assignees, invention history, patent class codes, citations
6.	Navigation, monitoring possibilities for inventions and infringements in regular R&D work, including creation of new ideas and inventions or invention principles [1)]	Patent claims and invention description

Note:

1) This is the traditional application of patent information. For illuminating historical accounts of how skilful inventors have traditionally used patent information, see Hughes (1971) and Cooper (1991).

2) The highly skewed distribution of patent values presents a large difficulty in valuing a patent portfolio. Various other indicators and approaches must complement patent information, such as data on stock market responses to patent related news, panel data or questionnaire data. For surveys of this application, see Pakes and Simpson (1989), Schankerman (1989), Griliches et al. (1988), Griliches (1990), Trajtenberg (1990), and Scherer (1998).

9.2.3 Some caveats when using patent statistics

It is tempting to use patent statistics for a number of purposes. Especially since patent statistics have been made available electronically, the propensity to use them for indicative purposes has increased. It is likely that this use of patenting information will grow and new indicators, methods, data bases and services will come into use, based on patent statistics combined with other types of statistics, as mentioned above. It is then important to recognize general caveats, sources of errors and factors to consider, both when using and producing patent statistics. A list of such factors to consider would include:

1) Purpose of analysis (e.g. benchmarking)
2) Company consolidation (so that e.g. patent counts and R&D statistics refer to the same company entity)
3) Quality of patents (type of patent in terms of level of invention, blocking power, profitability and other technical, economic and legal qualities, etc.)[12]
4) Technological coverage (number and scope of claims)
5) Market coverage (applications and countries covered by patents for an invention)
6) Multiple classifications, reclassifications and creation of new patent classes in the patent classification systems
7) Reassignments of patents (e.g. among patent classes or company assignees)
8) Varying classification and citation behaviour and errors at the patent examination side
9) Whether patent counts refer to patent applications, patents granted, patents in force, priority patents or patent families
10) Whether patent counts refer to national patents, PCT patents and/or EPO patents
11) Grounds for nationality assignments of inventors and assignees
12) Fluctuations of patent counts over time, company, country and classes

[12] The technical and economic qualities of patents are typically very skewly distributed. See e.g. Scherer (1998) on the skew distribution of profits from different patents.

13) Competitor and inventor IPR strategies (e.g. decoy patenting, flooding or avoidance of certain types of patenting)

14) Links between R&D activities and patenting (e.g. time lags)

15) Links of patent classes with publication areas, product areas and industrial sectors (such matches are difficult and so-called concordance lists are often unreliable)

16) Differing patent systems and legal environments among countries

This listing is long but not exhaustive. Thus caution must be exercised when using and producing patent statistics, and any conclusive results must be fairly robust, and hopefully corroborated in other ways as well.

9.3 General techno-economic analysis

9.3.1 Techno-economic analysis and mappings in general

Mappings for managerial use are dominated by simple two- or three-dimensional graphs and matrices.[13] A general class of such mappings is what can be called techno-economic mappings over time, or *T/E/t*-mappings for short. These mappings relate the behaviour of some technology-related variable *T* to the behaviour of some economic variable *E* over time *t*. Typically *T* is a physically measurable attribute or technical variable (or vector), while *E* typically is a monetary or value-related variable (or vector). Sometimes a compound *T-E* variable, e.g. a productivity measure, is used as well. Figure 9.1 shows some examples of common *T/E/t*-mappings.

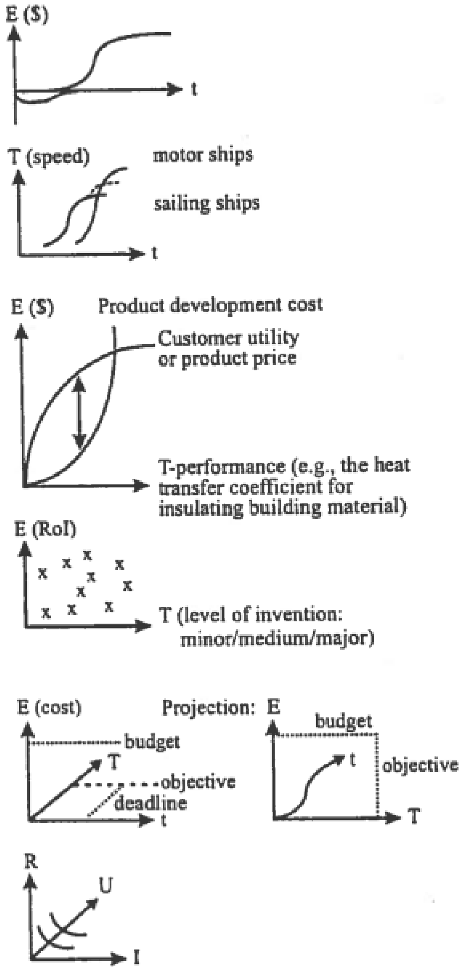
There is often a need to go beyond such common *T/E/t*-mappings and try to map out technologies, seen as the “soft“ competence parts, and link them to “hard“ (i.e. physically

[13] This is partly due to presentational reasons, partly due to need for simplicity. The latter is often overplayed by various consultants, who appear to assume that modern professional managers suffer cognitive limits (rather than time limits). A severe shortcoming of the low dimensionality of mappings for managerial use is that the time dimension is often neglected, thereby inviting only a static analysis.

measurable) technical dimensions and then ultimately link them to economically oriented dimensions. Various sources of technical information as described above, can be used for this additional category of technology mapping.

Figure 9.1 Examples of techno-economic mappings[1)]

Type		Example
1.	E/t	Product life cycle/ cash flow curve (cf. Figure 3.1)
2.	T/t	Technological substitution (cf. Figure 7.4)
3.	E/T	Price/performance diagram, e.g., for assessing quality objectives or product positioning
4.	T/E	Correlation between level of invention and return on investment (RoI) for a sample of innovations (cf. Section 5.8.1)
5.	T/E/t	R&D project management
6.		Compare pure $T_1/T_2/\ldots$ diagrams in science and engineering (e.g., Ohm's law U = RI)



Legend:

T = technology-related variable, usually related to physically measurable variables, describing design characteristics or technical performance of some sort (real or expected).

E = economic variable, usually related to values or monetary flows (real or expected).

t = time.

Note: Several *E*- and especially *T*-variables may be needed. It may be difficult to quantify the variables on higher-order scales (that is, to use metric and normed scales rather than only nominal and ordered scales). However, a conceptual analysis is always possible.

Figure 9.1 Examples of techno-economic mappings

Figure 9.2 shows a general framework for doing such an extended techno-economic analysis at business and company levels. Briefly, the framework at business level consists of constructing a series or family of mappings (which may be partial and qualitative) among the following sets of elements:

Mapping elements

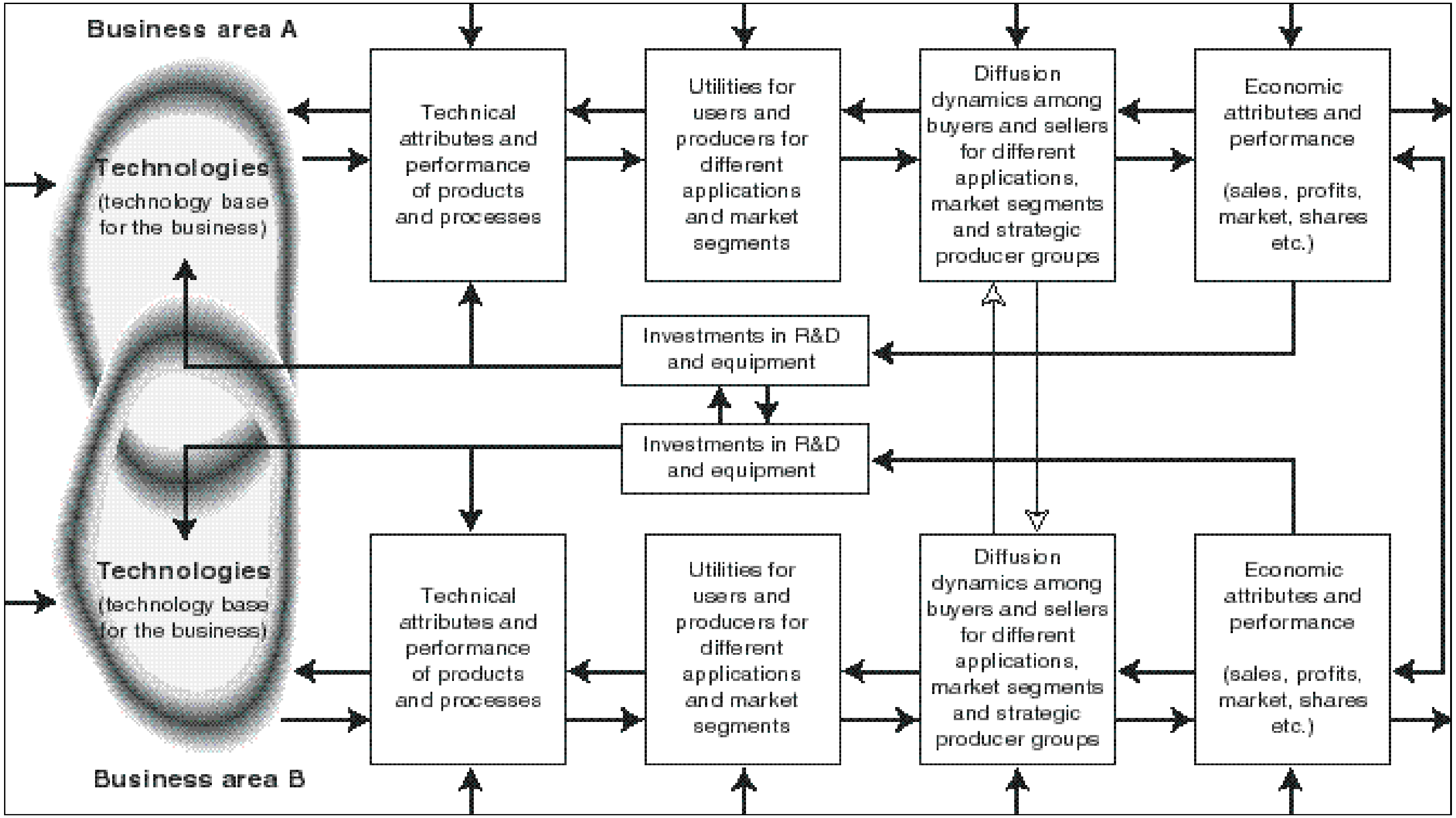
1) Technologies in the technology base of the business (cf. Chapter 4)
2) Technical design and performance variables of the product, services and production processes
3) Customer (or user) utilities and producer costs
4) Applications (i.e. usage systems with similar physical interaction with the product; see Chapter 6)
5) Market segments (i.e. clusters of buyers with similar purchasing behaviour)
6) Strategic groups (i.e. clusters of sellers with similar strategic behaviour)
7) Market penetration or diffusion processes among buyers and sellers of the product (being influenced e.g. by commercialization strategies; see Chapters 3 and 6)
8) Economic outcomes (growth, profits, market shares, etc.)
9) Investments in R&D and new technologies, production equipment, marketing, etc.

Technology base

For a company with several business areas, their technology bases may overlap (as may their entire resource bases). The linkages across business areas and between the technology bases and the business characteristics must then also be mapped out (e.g. for reaping economies of scale and scope in diversification, see also Chapter 4). One central feature of this approach to techno-economic analysis is the notion of a technology base (or technical competence base) of a product and of a company. The technology base of a product and of a company consists of those technologies and sub-technologies that are related to the product and the company respectively. The technology base can be built up in various ways through investments in

R&D and new technologies (see Chapters 4 and 7). The technology base can also be exploited in various ways through investments in complementary assets, joint ventures, licensing out, etc. (see Chapter 6). If relations between the technologies in the technology base are considered as well, we can also talk about the technology system of a business or a company. Patent information is then useful for mapping out a technology base or a technology system.

Figure 9.2 A framework for techno-economic analysis at company level (with two business areas)



Technology vs. technical performance

Another central feature of this framework is the mapping between “soft“ technology and “hard“ technical performance and functionality.[14] Different sets of technologies typically allow for different attainable levels of performance. Technology is defined, as elsewhere in this book, as a body of knowledge about industrial techniques, which are patentable in principle.[15] However, the term “technology“ is sometimes used to denote an area of possible knowledge as well, in contrast to the body or content of knowledge per se that can be classified as belonging to the area. This can give rise to misunderstandings. Take an example. A patent class constitutes a technological area (at the corresponding level of classification) while a patent that falls into the patent class is part of the technology or body of knowledge in that area.[16] Thus, we have to distinguish between technology and technological area, just as bodies versus areas of competencies in general have to be distinguished in many cases. The matter is further complicated by the fact that knowledge is not easily classified and the definition of different classes depends on the knowledge at hand. Thus, it may be necessary to use multiple classifications as well as to redefine existing classes and add new classes as new knowledge emerges.

Techno-economic links

A third feature of the framework is the mapping that explicitly links (technology-related) technical variables with economic variables. There are two such mappings at the product business level: one that links technical performance to customer utilities and producer costs, and one that links economic variables to technical ones through investments in new technologies and equipment.

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[14] Function, functionality and set of dimensions of a technical performance variable or parameter are taken as roughly synonymous concepts here.

[15] Technology, technical knowledge and technical competence are also taken as synonymous here, although one may, when needed, distinguish between knowledge and skills and let the concept of competence encompass both knowledge and skills.

[16] Similarly a publication class in some library classification has to be distinguished from a specific publication belonging to that class.

Technology diffusion

A fourth feature is the analysis of diffusion of new products among buyers and the diffusion of their production technologies among sellers (see Chapter 3). To trace technology diffusion among sellers, patent information can be used to indicate entries and exits of different firms in different technological areas. Also, the diffusion of a generic technology into various application areas can be mapped using patent information.

We will confine ourselves for now to those mappings that especially deal with technologies, i.e. technology mappings for which patent mappings are useful. These will be illustrated in the next section.

9.4 Patent mapping in Japan[17]

9.4.1 General description

As mentioned in Chapters 5 and 8, special methods, subsumed under the label "patent mapping", have been developed in Japan in the post-war period. Various methods of analyzing patent information have been developed in the West as well. To some extent the methods are similar, as they draw on the same type of information and use similar approaches. However, the degree to which such methods are systematically developed and employed on a broad scale appears to be much higher in Japan. In many Western firms the activities geared towards analyzing patent information are fairly straightforward and often simply consist of watching new patents in some narrowly defined set of patent classes that are traditionally thought to be of persistent relevance to the firm. Copies of the front pages of relevant patents are then regularly distributed among R&D personnel, who are encouraged to seek further information from the central patent department when the need arises.

Activities of this sort might sometimes be sufficient in small firms with a narrow product range and keen patent engineers and patent attorneys. More often, though, a

[17] Helpful discussion with and comments from A. Mifune, K. Norichika and Y. Tanaka on this topic are gratefully acknowledged, as is the material from JPO and translation work by M. Magnusson and T. Ide.

rudimentary level of patent analysis results from inadequate resources - perhaps only a part-time engineer and a secretary are employed. Sufficient or not, this type of patent analysis could rather be called “patent watching“ in contrast to “patent mapping“. Below, patent mapping will be briefly described together with some examples. However, the exposition is introductory and not intended to be anything like a handbook or manual.

Patent maps are produced for different purposes (see below), using different pieces of patent information which are refined, analyzed, interpreted, and represented in various ways. Usually patent maps take the form of 2- or 3-dimensional diagrams, graphs (e.g. networks), tables or matrices. The common dimensions (or variables) in patent maps are:

Dimensions in Patent Mapping

1) Time
2) Patent class, sub-class etc. (equated with technology, sub-technology etc.)
3) Function and sub-function
4) Application and sub-application
5) Product and sub-products
6) Actors (e.g. inventors, firms, nations)
7) Industry class or characteristic
8) R&D resources

Categories such as patents, technologies, functions, applications and products are all possible to distinguish at various levels in a larger classification system, which could be universal or tailored for a specific situation. For categories such as these, scales are constructed, showing e.g.:

Scales in Patent Mapping

1) Number of patents granted or patent applications

2) Number of products

3) Number of patent applicants (assignees, firms, inventors)

Numbers like these may be calculated as annual or cumulative (over some time period) and are in general used as a measure of relevance or weight of some sort, pertaining to levels or changes in levels of the scale. Based on numbers like these, patent profiles may be constructed for products, technologies, inventors, companies, nations, industries, regions etc.

The graphs, networks and matrices are then obtained by combining the dimensions, e.g. into:

1) Patent class by patent class network, with relations based on side classifications or citations or linkage to a common product, function, application, inventor, firm or other patent (see example below)

2) Technology-by-product matrix with patent linkages

3) Technology-by-industry matrix with patent-based relevance measure

4) Product-by-product matrix with patent linkages

5) Split drawings with sets of relevant patent classes, indicating the technology bases of the components (sub-products)

9.4.2 History of patent mapping in Japan

Patent mapping was originally developed at the JPO in the 1960s for the purpose of facilitating the patent examination process. The first patent map in Japan was published by the JPO in 1968; see Figure 9.3.

The first patent map showed the extension of an air micrometer measuring technology into various product functions, features and design principles and into various application areas. The map also showed how the extensions into functions on one hand, and applications on the other, are linked through the flow of patents over time.

Gradually, the main locus of developments as well as applications of the patent-mapping methodology shifted over to industry, especially to the large technology-based corporations. At the same time the range of purposes and specialized methods broadened. Altogether, patent mapping has developed into a useful tool not only for IP management and technology management at large but also for R&D work. Thus patent mapping could be considered an innovation, and as such comparable to innovations like project-planning methodology (PERT, CPM etc.) and technological forecasting methods. In addition, patent-mapping methodology has a large potential for being developed further, e.g. together with other methods and indicators for technology analysis and technology management. It should also be kept in mind that benefits from the use of patent information is in line with the intentions of the patent system from society's point of view (see Chapter 3). However, since the costs and benefits of developing special methods for analyzing patent information may be great, developers may be induced to keep them partly secret in turn. It is also becoming increasingly difficult to make effective use of patent information because of the large and growing amount of such information, the ever-changing focus of R&D throughout a broad range of technologies and a shortage of adequately trained experts, a shortage that is felt also in Japan.[18]

9.4.3 Purposes

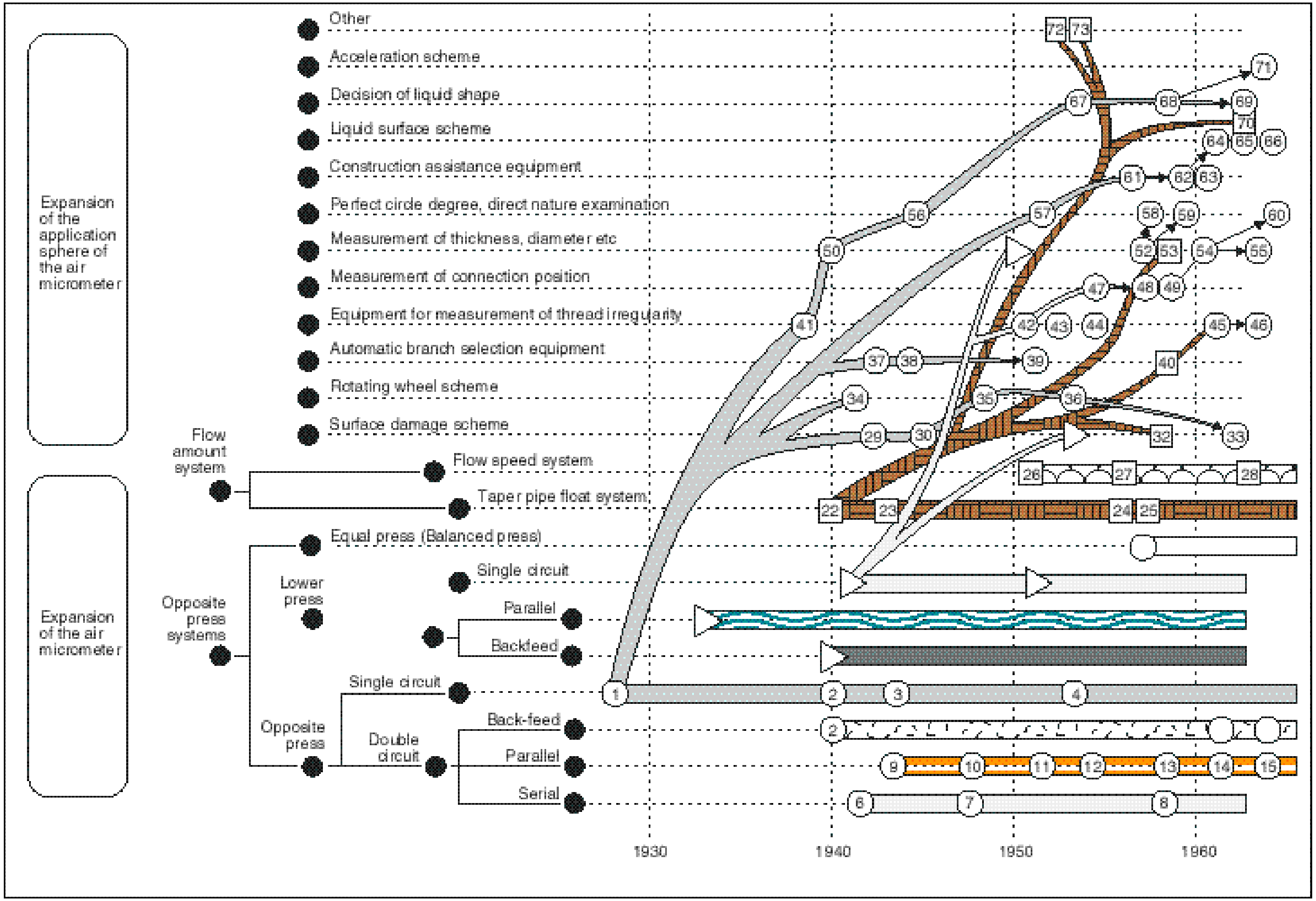
There may be many purposes and applications for patent mapping. Seven purposes will be outlined below. It should also be kept in mind that patent mapping is but one tool for techno-economic analysis as described earlier. Complementary information, e.g. about business directions, is generally needed, particularly when combining patent maps with market analysis.

Creative tool

An important purpose of patent mapping is to assist in the creation of new ideas. In fact, through regular patent-mapping activities, the IP department and patent mappers, wherever they are located in the organization, may become an essential source of inventive contributions. Thus through patent mapping the IP department may adopt a much wider role in the R&D organization than is usually recognized, at least in the West (see also Chapter 8).

[18] Hence, it could be argued that PTOs or some other public agencies should take part in developing and disseminating such methods.

Figure 9.3 First patent map (published by JPO)



Intelligence tool

A second purpose is to aid in technology analysis and business intelligence activities. This is comprised of identifying technology trends, company (competition) trends and market trends. New patentors (firms) with new technologies may be discovered and possibly targeted for surveillance concerning licensing, acquisition or cooperation, as well as concerning highly productive outside inventors for possible hire-overs.

Patent maps may also be used to identify the structure of technology systems and relations among different technologies. The maps also show how much information is revealed to competitors by one's own patenting activities. This may in turn guide those companies who engage in decoy patenting, i.e. by patenting with an intention to misguide the technology intelligence activities directed towards their firm by its competitors. The actual extent of decoy patenting in practice is difficult to assess, of course, but appears to be very marginal. However, "blanketing" and "continuous" patenting strategies (see Chapter 7) may in effect decrease the possibilities for competitors to detect patterns in patent maps.

Management tool

A third purpose of patent mapping is to aid technology and R&D management in assessing the productivity and quality of the in-house R&D function, as well as of other technology-related functions, e.g. production and decentralized engineering, such as application engineering in subsidiaries.

Bargaining tool

A fourth purpose of patent mapping is to assist in negotiations. A good patent map is a useful indicator of the technological and legal strengths and weaknesses of one's own firm and of its competitor or partner, and as such, becomes a useful bargaining tool, especially if the competitor does not have similar information. Each party most likely has a patent map, possibly confidential and possibly differing in quality but nevertheless a map, which may be valuable in negotiating a license, settling disputes, avoiding court, lowering royalties and so on. But patent maps may also be helpful in finding and negotiating with partners for R&D cooperation, cross-licensing or for any type of technology acquisition and exploitation (see Chapter 6).

Litigation tool

A fifth use of patent mapping is in litigation and court situations, where it can be used to facilitate the process and influence all persons involved – outside lawyers, the defendant, judges, consultants etc. Thus a patent map may become a tool for litigation.

Communication tool

Certain patent maps are useful as a general communication tool, not least in explaining technology, product and competition matters to business and corporate management. Simple benchmarking, as presented in Appendix A, is also very effective in getting management attention.

Educational tool

Patent mapping is useful in educating not only patent staff but engineers and technology managers in general, as well as the competitor's intelligence people and legal personnel. Patent mapping is a concrete method that operates with fairly precise information in order to illustrate various issues critical to technology analysis. Patent mapping moreover illustrates technological developments, linking them to competition and commercial aspects as well as various issues in techno-economic analysis.

9.4.4 Examples

Some illustrative patent maps are shown below.[19] A patent network map is shown in Figure 9.4, a patent-by-country map in Figure 9.5, a patent-by-technology map in Figure 9.6, a patent-to-product map in Figure 9.7 and finally a patent-to-product matrix in Table 9.3. Note that Table 9.3 links inventions or technologies to different technical characteristics of the product, some of which are directly affecting customer utilities and manufacturing cost. However, it is outside the scope here to draw any inferences from the examples. Needless to say, there are numerous other types and variants of patent maps, depending upon the purpose. Finally, Figure 9.8 shows how Toshiba performs patent reviews in every step of the innovation process, and how patent mapping feeds into this review process, and Figure 9.9 shows the patent information system at Hitachi.

[19] By courtesy of JPO.

Figure 9.4 Example of patent network map

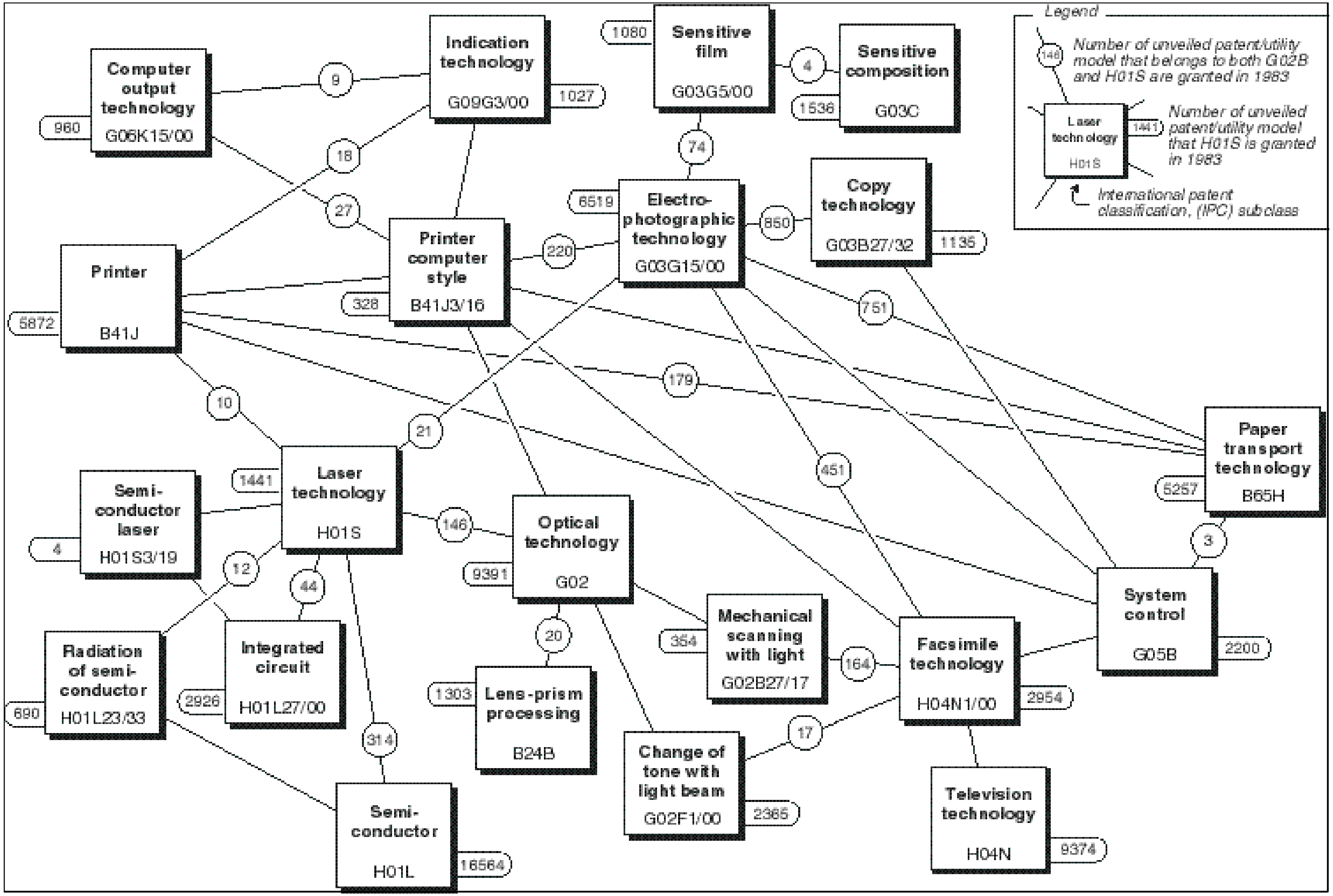


Figure 9.5 Example of patent-by-country map

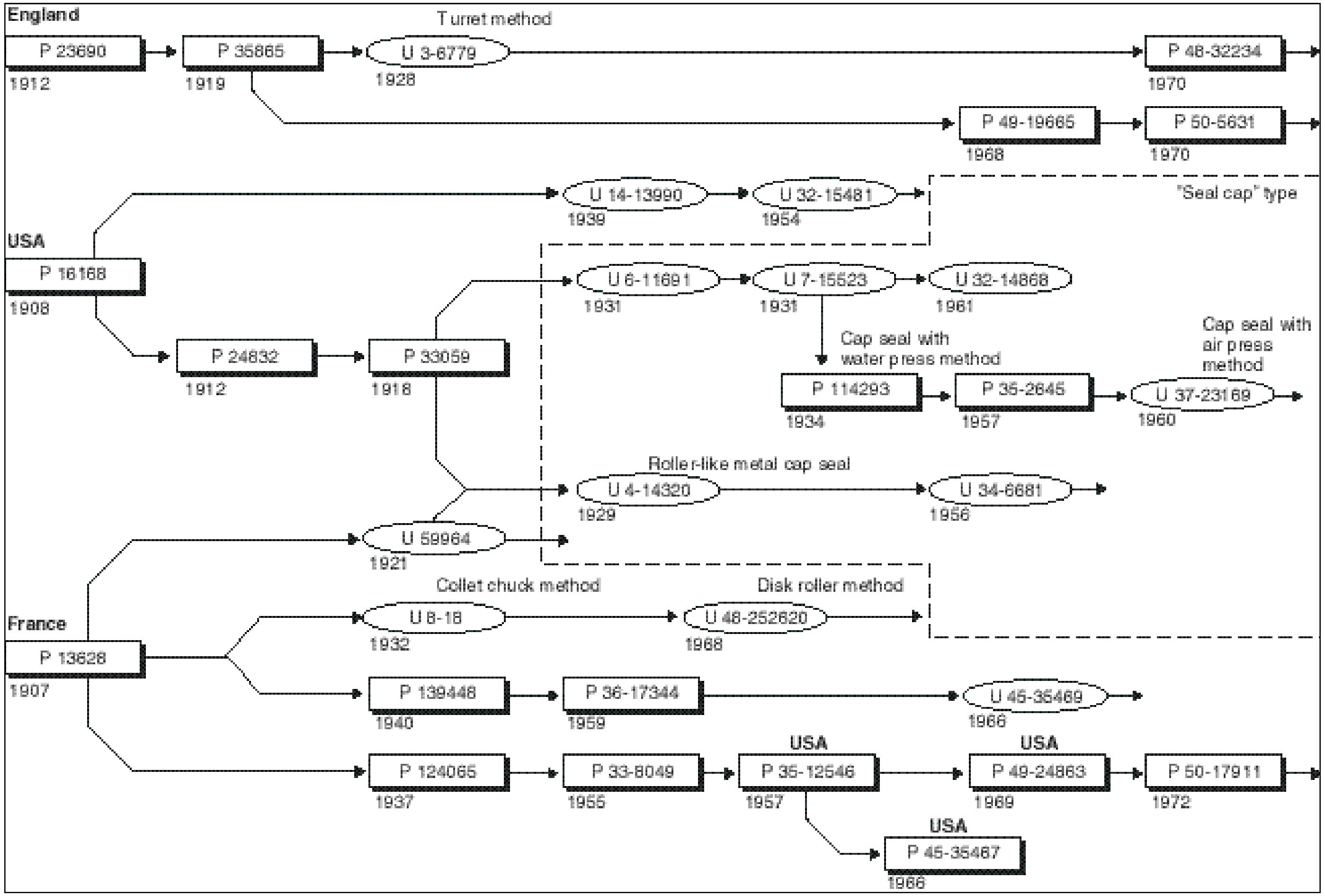


Figure 9.6 Example of patent-by-technology map

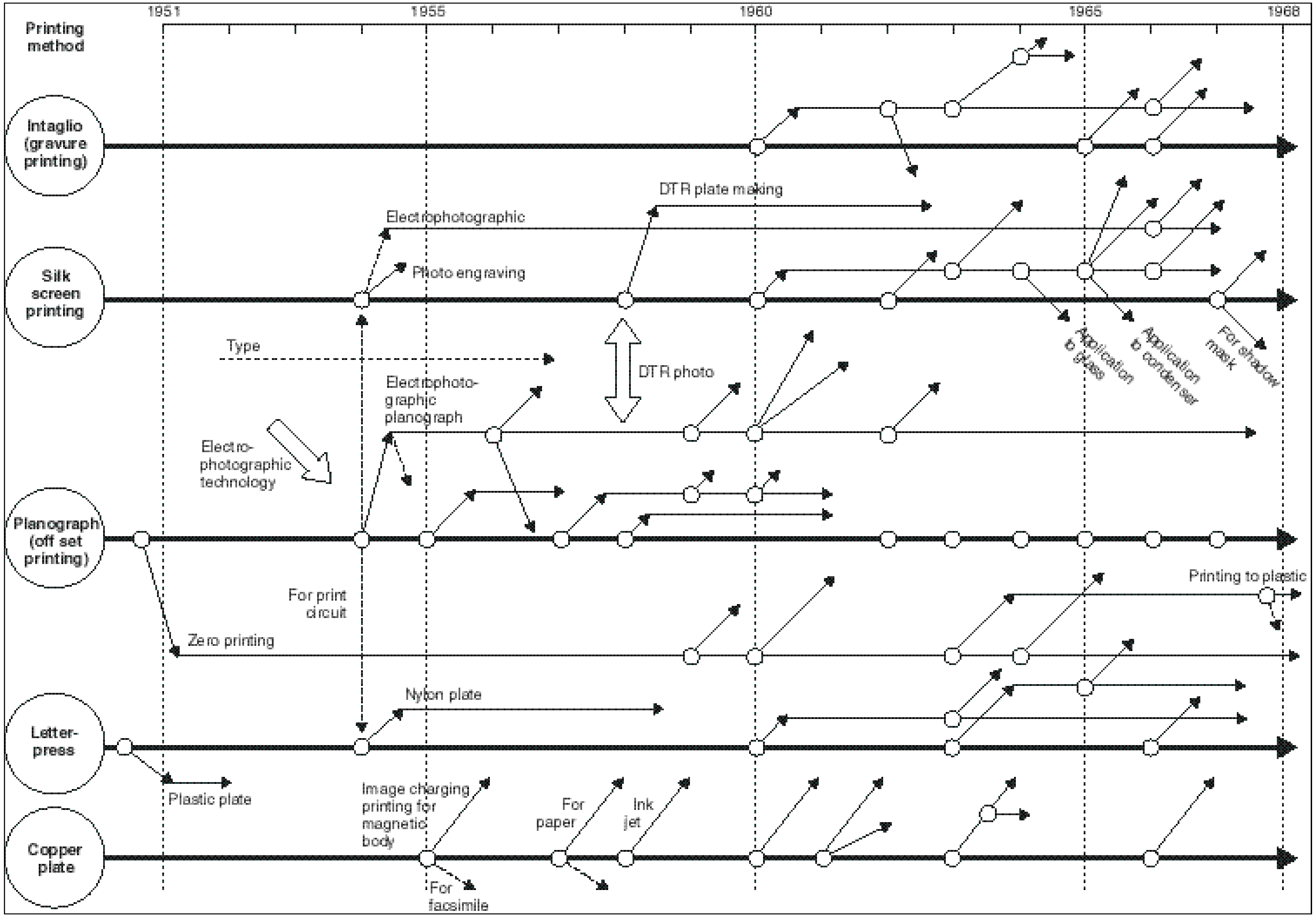


Figure 9.7 Example of patent-to-product map

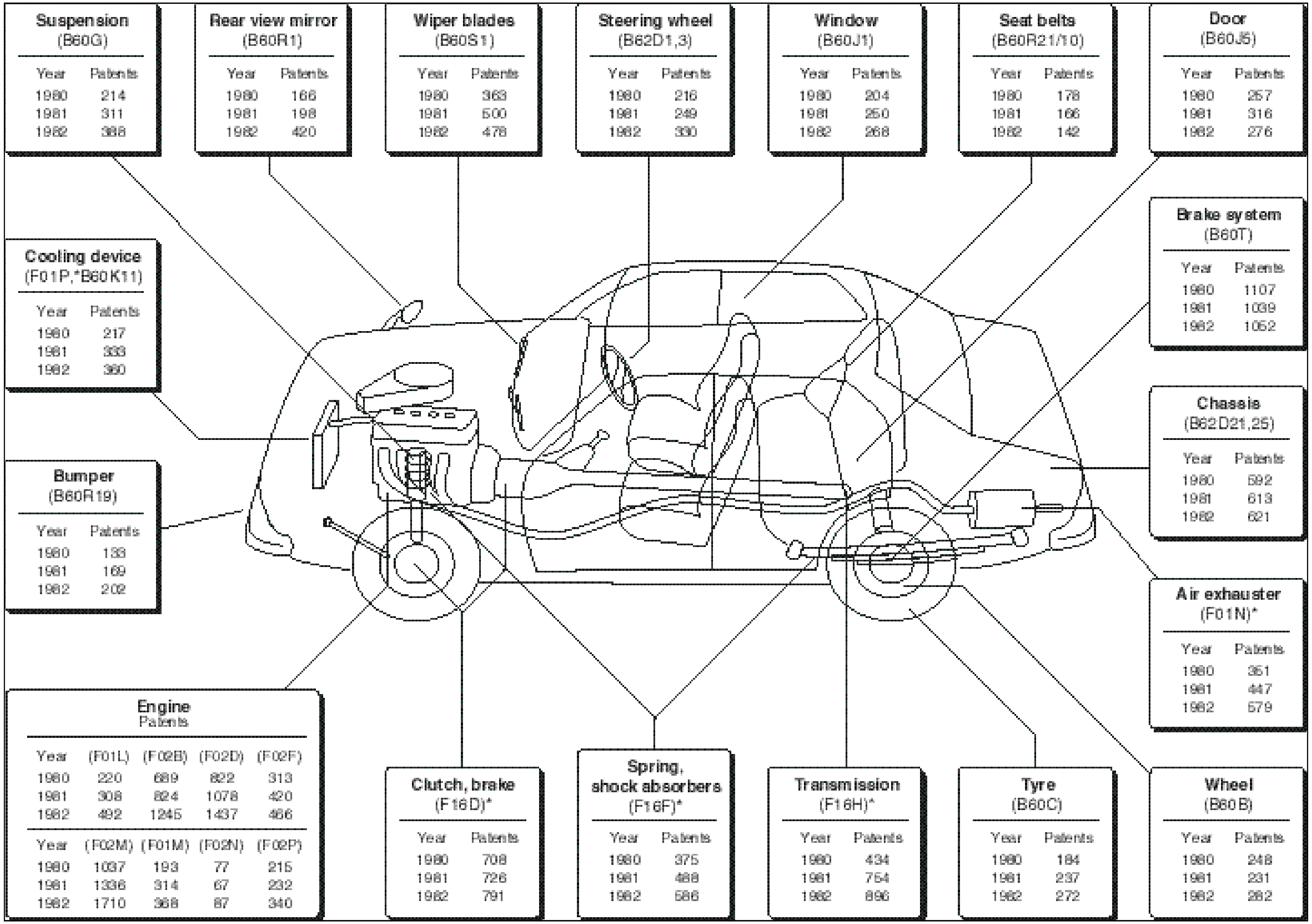


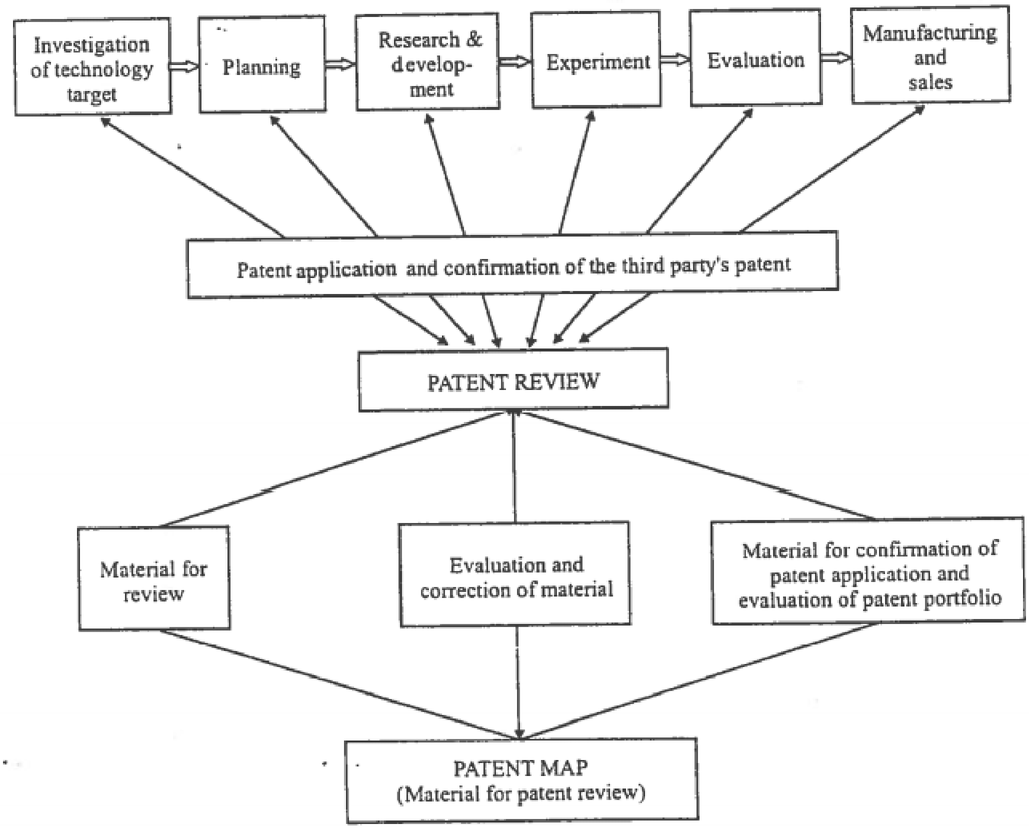
Table 9.3 Example of invention-to-product matrix

Table 9.3 Example of invention-to-product matrix

		Composition																
		Material						Manufacturing method							Form			
		Core			Clad													
Date of application No. of notification	Name of invention *Applicant*	Quartz and double quartz glass	Glass with other ingredients	Others	Quartz and double quartz glass	Glass with other ingredients	Others	Flame oxidation method	Method with two melting pots	Layer fusion method with indication powder	Ion exchange method	Pull-out method	Fibre bundle formation roll method	Dope material and dope method	Flood pattern	Distribution pattern	Multiple layer pattern	Others
62.5.25 48-30125	Glass formation technique *Owens-Corning (?) Fibre Glass Corporation*	•					•											
38.6.22 48-30126									•						•			
63.2.14 48-31734	??									•								
44.5.7 48-37696	??															•		
44.9.25 48-37731	??		•								•					•		
44.3.22 48-37852	Method for manufacturing plastic fibre optics plate *Fuji Photo Film*																•	
44.7.28 48-37854	*Matsushita*																	
44.9.25 48-28267	??		•											•		•		
44.12.23 48-38268	??																	
69.3.28 48-38269	??																	
69.6.9 48-33291	??											•			•			
41.4.14 49-212	??												•					
69.1.24 49-904	*Western Electric*																	
42.1.19 49-4344	Optical thin film Olympus Optical Co. Ltd	•					•										•	

Effect									Others									
Improvement in characteristic					Improvement in control				Fibre cable		Fibre			Tools				
Optics special quality	Diffusion zone limits	Mechanical strength degree	Chemical strength degree	Others	Refraction coefficient	Homogeneity quality	Section organisation	Others	Jacketing	Cabling	Splicing	Polishing	Lens processing	Form	Formula	Joining operation	Light-IC	Notes
			●															Composition made up of silicate and alumina with 4–25wt% Mg added
					●													
					●													
●		●																
								●										
					●							●						
					●													
								●			●							
●																		
								●										
								●						●			●	
●																		Mixture of $CeF_3 + MgF_2$ and mixture of $CeO + CeF_3$ are set to clad separately

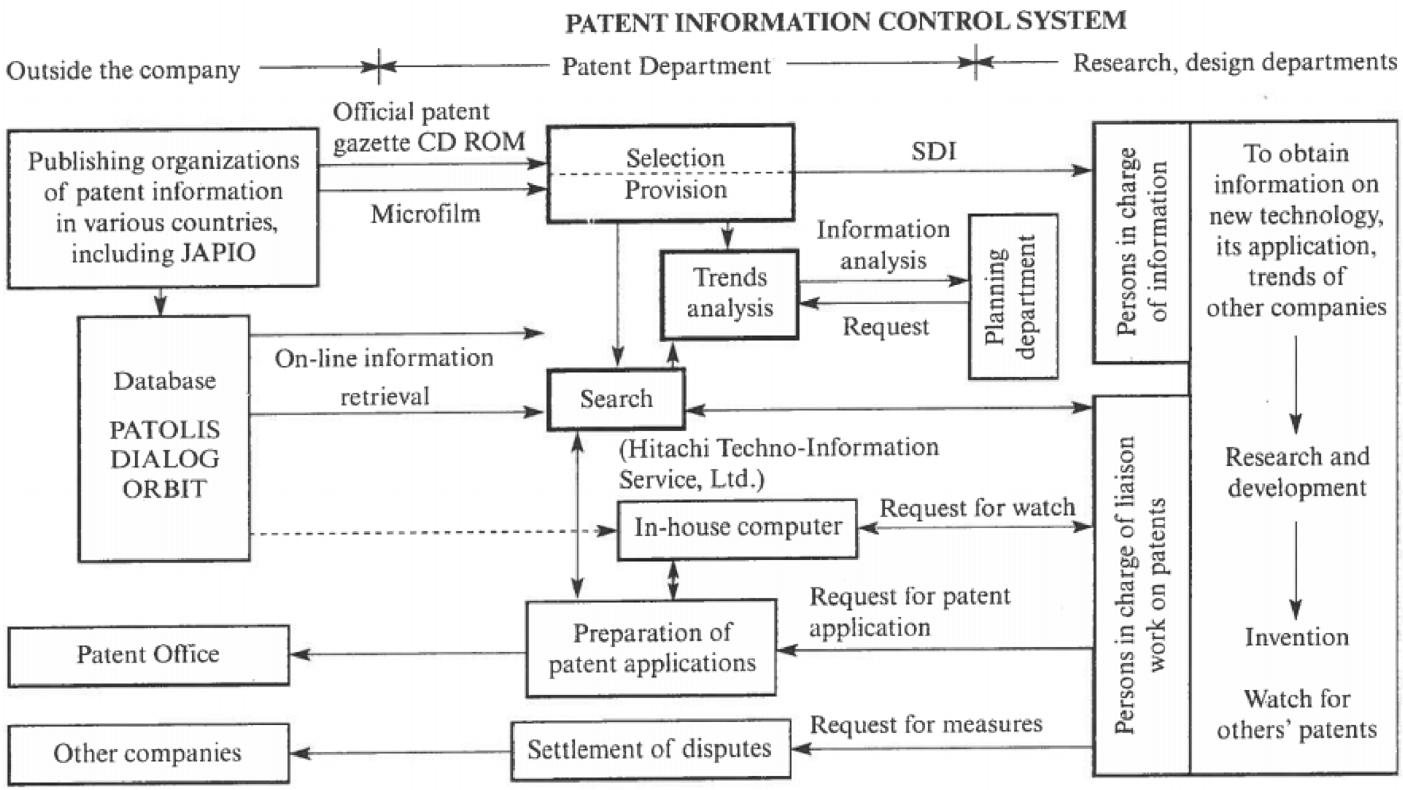
Figure 9.8 Patent review structure in Toshiba



Source: Document provided by Toshiba.

Figure 9.8 Patent review structure in Toshiba

Figure 9.9 Hitachi's patent information control system



Source: Document provided by Hitachi.

Figure 9.9 Hitachi's patent information control system

9.5 Summary and conclusions

The stock of publicly available patent information in the world is in fact a tremendous and unique source of technical knowledge. For various reasons (such as lack of time, costs, varying information quality, ignorance), this source of information has traditionally been underutilized, but the ongoing computerization of the patent system rapidly offers increasing possibilities to tap this valuable resource. The costly and tedious act of digging into patent archives and the subsequent distribution of patent documents are gradually being replaced by computerized patent databases, data mining and information processing, thereby drastically improving both the costs and benefits for companies using patent information. At the same time, patenting propensities have increased and become more consistent, increasing both the quantity and quality of patent information. However the set of basic information items for a given patent has changed very little.

The present study as well as other studies show how companies have increased their use of patent information and consider such information to be one of the most important means for technology and competitive intelligence. It is significant that most companies have not considered the avoidance of patenting worthwhile in preventing other companies from finding out about their own technical developments. This is an indication that patenting may provide net benefits to industry as a whole (i.e. patenting could be considered a positive sum game in this respect.)

The literature on the use of patent information as technology indicators and/or economic indicators has grown rapidly as well, and this chapter gives a number of references. Patents were also compared with other technical information carriers, such as publications. Several application areas of patent analysis were described, such as competitor benchmarking, technology analysis, international patenting analysis, valuation of technology assets and tracking of key inventors, together with a number of caveats. Patent analysis was then put into the general context of a framework for techno-economic analysis, which could be used to integrate various applications of patent analysis.

From this general description, the chapter then described the nature and origin of the so-called patent mapping methodology developed in Japan. Broadly speaking, patent mapping mainly uses patent information as technology indicators. This methodology originated in the Japan Patent Office in the 1960s and has since been adopted and developed further in industry and in the leading large corporations in particular. Patent maps have a variety of applications, for example as a tool for creativity, intelligence, technology management, bargaining, litigation, communication and education.

The chapter finally gave a number of fairly simple illustrations of patent maps including a patent network map, a patent-by-country map, a patent-by-technology map and a patent-to-product map and illustrations of how Toshiba and Hitachi have organized patent information analysis.