

**Strategic Intellectual Property  
Portfolio Management:  
Technology Appraisal by Using the  
“Technology Heat Map”**

**Masayuki MIYAKE, Yuji MUNE, and Keiichi HIMENO**

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The research and development (R&D) investment of major manufacturers has reached an annual level of several hundred billion yen. Questions are being raised as to whether this investment amount is efficient from the perspective of its effectiveness. Company executives now face a variety of opportunities that require sophisticated analyses and decisions. These include the re-evaluation of intellectual property portfolios centered on patents held by a company, and evaluation of the business values of candidate companies in considering M&A (merger and acquisition).

To help support the intellectual property portfolio management of these companies, Nomura Research Institute (NRI) has developed a new analysis solution called the “Technology Heat Map.” This method analyzes the status of patent applications filed in specific technology fields and provides visualizations of the technology fields that each company is focusing on as well as highly competitive fields. Accordingly, this map can be applied as an analytical method to support the formulation of R&D strategies, the search for target companies for M&A and the evaluation of intellectual property portfolios.

This solution is expected to offer a common-language-like role for people in industry, academia and government who recognize the importance of information sharing in the operation of intellectual properties.

# I Company's R&D: Current Status and Required Improvements

## 1 High-Level R&D Investment and Improvements Required of Management

The research and development (R&D) investment by major Japanese manufacturers has amounted to an annual level of several hundred billion yen. These leading companies have continued aggressive R&D investment even after the collapse of the bubble economy (Figure 1). However, questions are being raised from the perspective of investment effectiveness, such as whether such investment is made efficiently and whether the results of R&D are appropriately contributing to company profits.

What is required of the management of manufacturers is to make selective investments, continue to introduce competitive products to the market and achieve sustainable growth of core businesses. Another possible strategy is to develop next-generation core businesses and accomplish continued company growth. In pursuit of these goals, the improvement of investment efficiency by reviewing R&D and the reorganization of a business portfolio have become urgent issues to manage. In relation to these trends, opportunities requiring sophisticated analyses and judgments in the decision-making process of corporate management have recently been increasing. These opportunities include the re-appraisal of intellec-

tual properties such as patents, the strengthening of licensing agreements and the evaluation of the business value of the target company at the time of mergers and acquisitions.

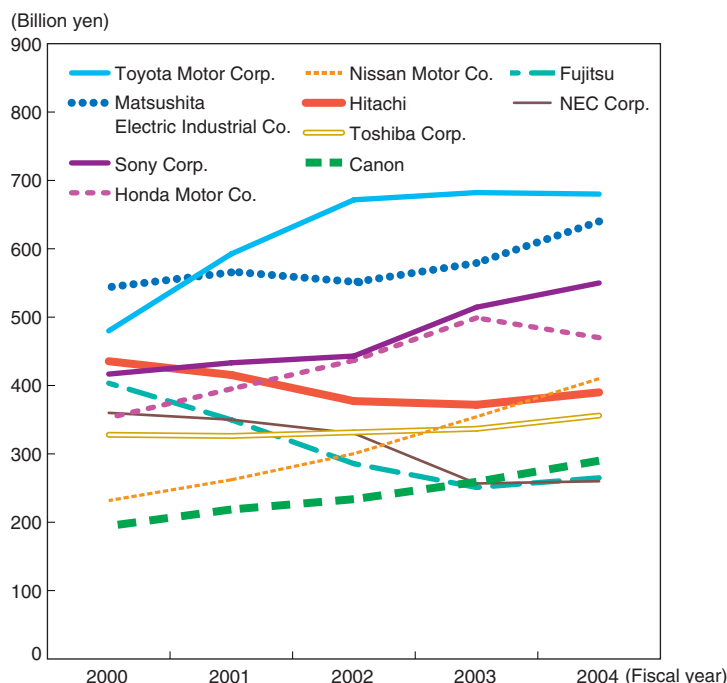
## 2 Sluggish Ranking in World Competitiveness

According to the *World Competitiveness Yearbook 2004*, published by the International Institute for Management Development (IMD) in Switzerland in May 2004, which covers 60 world economies and regions, Japan ranked 23rd in terms of overall capabilities (Table 1). Compared to the years around 1990 when Japan left all other countries far behind by being propelled by the favorable wind of the bubble economy, Japan's sluggishness is still conspicuous. The United States continued to rank 1st, Singapore ranked 2nd (4th in the previous year) and Canada ranked 3rd (6th in the previous year). Ranked at 24th, China is closing in on Japan with a difference of only one rank.

Looking at the breakdown of factors that positioned Japan 23rd in overall capabilities, Japan was ranked 17th for economic performance, 37th for government efficiency, 37th for business efficiency and 2nd for infrastructure. The principal factors behind the low rank for business efficiency are closely related to the lower ranks given to rights and responsibilities of shareholders (59th) and shareholder value (59th).

While the ranking of infrastructure was raised from 3rd last year to 2nd, higher ranks occupied by the following factors have contributed to this elevation: patents granted to residents (1st), securing patents abroad (2nd),

Figure 1. Changes in R&D Investment by Major Companies (on a Consolidated Basis)



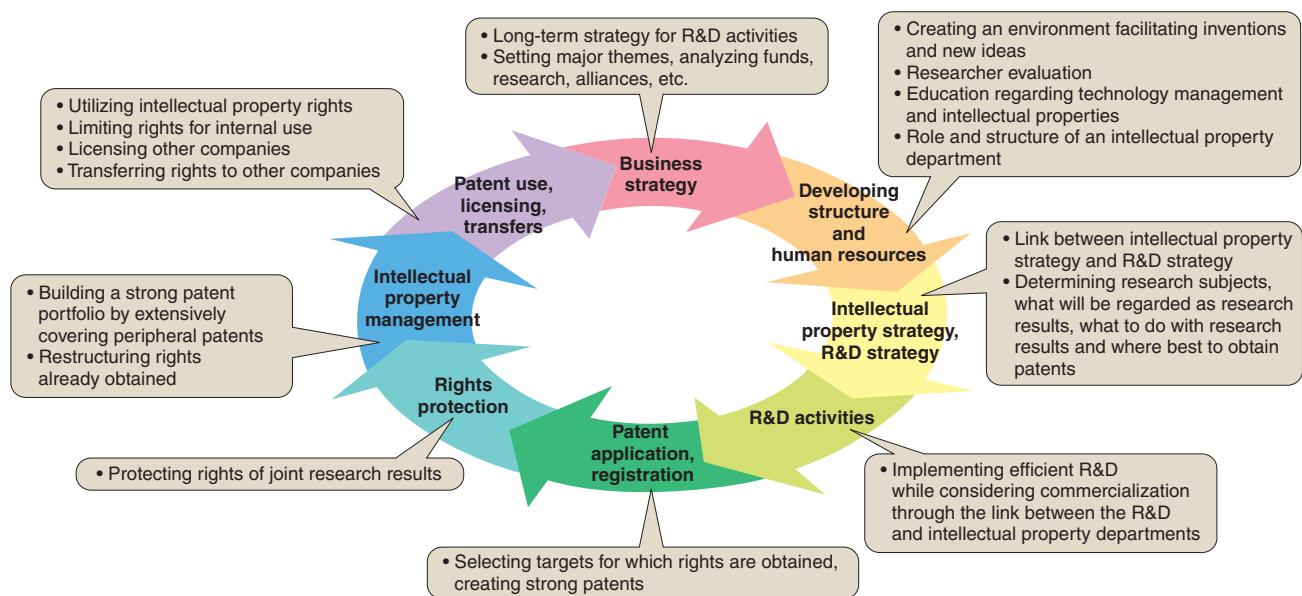
Note: Figures used for fiscal 2004 (April 2004 – March 2005) are budgetary amounts. The fiscal term for Canon is January to December. Source: Compiled based on financial data announced by each company.

**Table 1. World Competitiveness Ranking**

	Japan	US	China
Overall Capabilities	23	1	24
Economic performance	17	1	2
Government efficiency	37	10	21
Business efficiency	37	1	35
Infrastructure	2	1	41
Capability of Science and Technology	2	1	23
Total expenditure on R&D	2	1	6
Total R&D personnel nationwide	3	–	1
Basic research	9	1	11
Science in schools	33	31	19
Patents granted to residents	1	2	9
Securing patents abroad	2	1	32
Patent and copyright protection	26	6	41

Note: One of the factors that determine the ranking for infrastructure in the overall capabilities is the capability of science and technology.  
 Source: IMD, *the IMD World Competitiveness Yearbook 2004*.

**Figure 2. Ideal Management Cycle for Activities for R&D and Intellectual Properties**



total expenditure on R&D (2nd) and total R&D personnel nationwide (3rd).

These findings suggest that although the factors of investment in R&D and the number of patents acquired occupy higher ranks, these higher rankings do not necessarily contribute to the improvement of Japan’s world competitiveness in its overall capabilities.

### 3 Difficulty in Introducing an Intellectual Property Management Cycle

Recently, the disclosure of information in a variety of fields has been facilitated in the format of electronic data such as a company’s financial data, market-related data and information and official reports on applications for patents resulting from R&D. Accordingly, an environment is being established where information is easier to acquire. However, because the volume of such information is enormous, it has conversely become difficult to analyze such information and extract key information that is essential for making management decisions.

Ordinary manufacturers conduct R&D activities to further strengthen their strong technological fields, and increase their competitiveness by manufacturing attractive products with greater added value. To cope with their weak areas, they usually adopt the strategies of combating their weaknesses by introducing technologies from outside companies and/or establishing alliances with them.

However, with respect to patents that are the direct results of R&D, manufacturers face a variety of problems. (1) The expressions used for patent specifications are difficult to understand. (2) It is difficult to envision final products because element technologies cover extensive fields. (3) Because large companies apply for a large number of patents, it is difficult to make comparisons with other companies. Therefore, there are only a limited number of cases in which patents are considered in determining R&D strategies.

Essentially, activities for R&D and intellectual properties must be dealt with in the management cycle shown in Figure 2. In addition to their excellence in R&D capabilities, the following point can be considered

characteristic of companies that properly implement R&D and manage their intellectual properties. The executives of such companies make strong public announcements concerning the strengthening of their R&D activities and their intellectual properties as an important part of their company's business strategies.

However, there are only a few companies in which this management cycle is functioning properly, such as IBM and DuPont. Many other companies continue to face the need to strengthen these activities.

#### 4 Start of Activities to Publish Intellectual Property Reports

In 2004, some companies that have taken innovative approaches to intellectual properties began to publish intellectual property reports. The expectations behind these moves are to promote investment by outlining the company's R&D strategy to investors. Included are to what extent rights are created based on the patents resulting from such R&D activities, as well as to what extent revenues are generated by licensing.

The disclosure items suggested in the "Guidelines for Disclosure of Information on Intellectual Properties," which were announced in January 2004 by the Ministry of Economy, Trade and Industry (METI), are described below. The items disclosed by the companies that issued intellectual property reports this spring generally conform to those announced by METI.

- (1) Core technologies and business models
- (2) R&D segments and the direction of business strategy
- (3) R&D segments and the outline of intellectual properties
- (4) Analyses of technology marketability and market predominance
- (5) Organizations of R&D and intellectual properties, R&D cooperation and alliances
- (6) Policy concerning the acquisition and management of intellectual properties, the management of business secrets, and the prevention of technology outflow
- (7) Contribution by licensing-related activities to business operations
- (8) Contribution by a group of patents to business operations
- (9) Policy for intellectual property portfolio
- (10) Information on risk management

While manufacturers have started to deal with various IR (investor relations) activities, including the publishing of these intellectual property reports, it is not easy to properly show the efficiency of the company's R&D investment and the effectiveness of the procurement of technology from outside such as through M&A. It is true that concerns about a fluctuation of technological pre-

dominance over competitors that might result from the disclosure of information related to intellectual properties are also involved because the R&D strategy and the intellectual property strategy exactly represent the business operation strategy of a company. However, a major reason behind this difficulty is that it is extremely difficult to demonstrate explicitly the efficiency and the effectiveness of a company because a large number of patent applications are involved. In addition, individual R&D fields are extensive and wide-ranging.

The ideal method would be to consider a group of patents that are the results of the company's R&D as a technology portfolio, analyze the portfolio and publicly announce the company's innovative and competitive technological fields.

At the same time, in response to the announcements of such new information from companies, corporate research analysts are required to seriously analyze and evaluate such information. There are many manufacturers that spend amounts for R&D that exceed their amounts of capital investment. In response to these moves, institutional investors have started to show an interest in the content of R&D investment and the effectiveness and efficiency of such investment without being limited to examining the content of capital investment as in the past.

Thus far, corporate research analysts have closely examined the content of a company's capital investment. However, in actuality, they could not be so attentive as to evaluate the content of R&D investment that exceeds capital investment. Recently, however, they have started to shape their research activities by understanding the importance of analyzing the content of R&D investment and the technology portfolio. In the future, through such efforts by corporate research analysts, a totally new type of research report is expected to emerge that visualizes an outline of R&D investment by combining the analysis of financial data with that of intellectual property data.

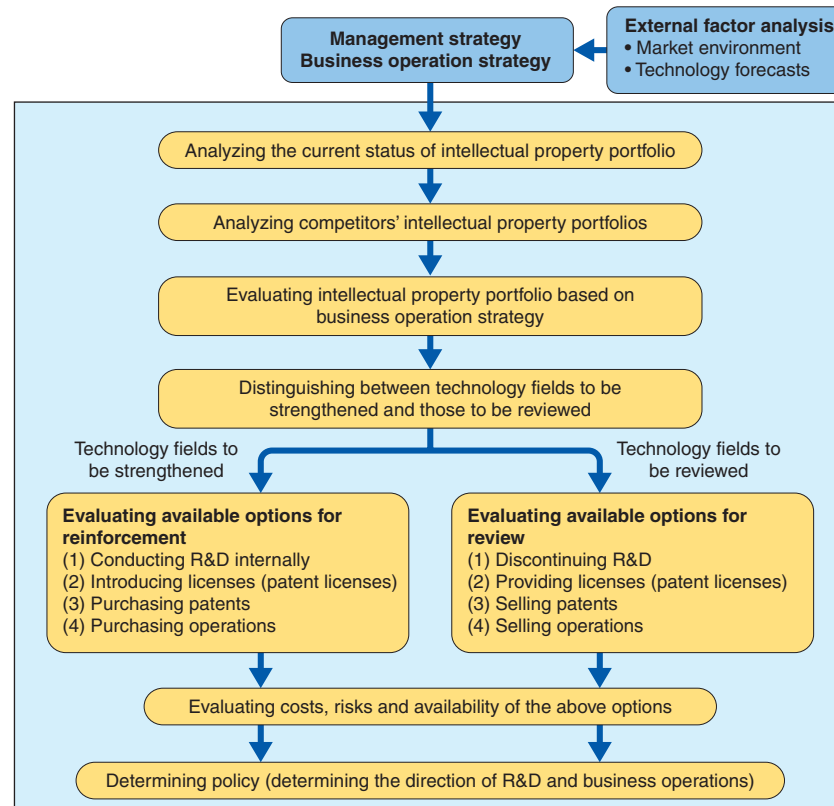
## II Proposing Strategic Intellectual Property Portfolio Management

### 1 Process of Intellectual Property Management

To support a company's "intellectual property portfolio management" based on the factors described above, Nomura Research Institute (NRI) has developed new solutions. The following section outlines the new solutions and the applications of such solutions in formulating a company's future management strategy (R&D strategy, M&A strategy, etc.).

As shown in Figure 3, the first step in the process of intellectual property management by general

Figure 3. Process of Intellectual Property Management



manufacturers is to identify intellectual properties centered on patents for each business segment in accordance with management and business strategies. These identified intellectual properties are collectively handled as a technology portfolio and are analyzed to evaluate whether they conform to the business strategy of each segment.

At the next step, the trends of intellectual property portfolios of competitors are analyzed to examine the possibilities of technology development with the objective of marketing similar products. Based on comparisons with a company's own intellectual property portfolio, decisions are made as to whether predominance can be established in the relevant market, and the direction of future R&D activities as well as patent applications is determined. Specifically, even if systematic activities are implemented, this decision relates to the determination on whether to compete with other companies in an area where many patent applications have already been submitted, protect such an area or withdraw from this area.

At the last step, the future policy for R&D is determined, based on technology fields that should be strengthened and those that require review.

For example, four options are available with respect to technology fields that should be strengthened: (1) conducting R&D within the company, (2) introducing licenses (patent licenses), (3) purchasing patents, and (4) M&A. Similarly, there are four options with respect to technology fields requiring review: (1) discontinuing

R&D, (2) providing licenses, (3) selling patents, and (4) M&A.

The company's management must decide on policies such as determining the direction of R&D and business operations after evaluating costs, risks and availability (i.e., whether the relevant option can actually be adopted) of each of these options.

As solutions that support the implementation of such strategic intellectual property portfolio management, NRI has developed two evaluation methodologies. One is PPM (patent portfolio management) analysis and the other is the Technology Heat Map analysis.

## 2 PPM Analysis

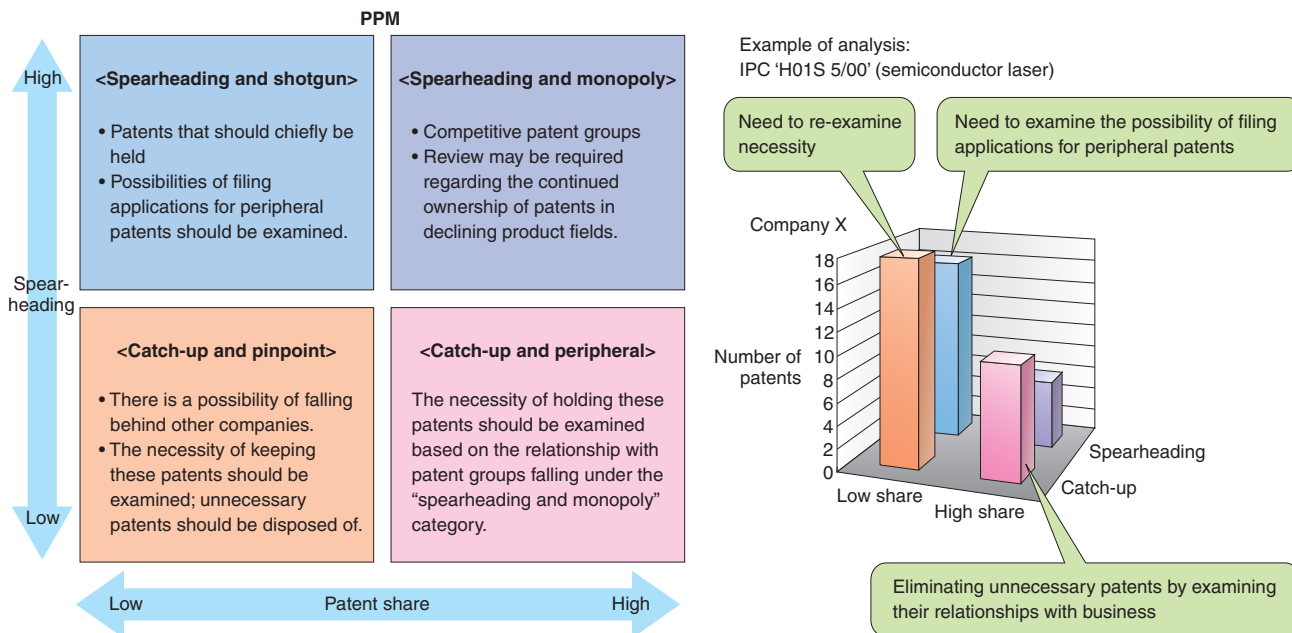
PPM analysis is explained in "Tokkyo hyoka bijinesu no kasseika ni mukete (Towards the Vitalization of Patent Evaluation Business)," *Knowledge Creation and Integration*, July 2003. This section summarizes the major points of this methodology. Overall, this method evaluates the company's patent groups by classifying them into four categories by "spearheading" and "share" (the ratio of the company's own patents among similar patents) (Figure 4).

### (1) "Spearheading and monopoly"

High degree of competitiveness with other companies. With respect to declining product fields, however, a review of continued ownership might be called for.



Figure 4. Overview of PPM Analysis



Note: IPC = International Patent Classifications.

(2) "Spearheading and shotgun"

Basically, there are many patents that should be owned by a company. It is also necessary to study the possibility of holding all related technologies by increasing the company's share through acquisition of peripheral patents.

(3) "Catch-up and pinpoint"

There is a possibility of falling behind other companies in terms of R&D. Verification of a portfolio's content is required.

(4) "Catch-up and peripheral"

If patents falling under the categories of "spearheading and monopoly" and "catch-up and peripheral" are well balanced, there are many cases in which specific technologies can be successfully held. With respect to cases involving few patents falling under the spearheading and monopoly category and many patents falling under the catch-up and peripheral category, the technology content must be verified.

### 3 Technology Heat Map Analysis

The newly developed Technology Heat Map analysis is designed to provide a bird's eye view of research fields for analysis based on patents and/or research papers that are the results of R&D. This method is effective for analyzing and evaluating intellectual property portfolios owned by companies and research institutes.

The analysis employs text mining technology, which is a new method of information analysis, and begins with a language analysis of electronic data of target patents and/or research papers. Through the language analysis, technical terms and keywords that express the features of

the technology are extracted and, at the same time, the frequency of use of such technical terms is determined.

At the next step, statistical analysis is conducted with respect to the extracted technical terms based on their frequency and the number of appearances in the same document (co-occurrence). The distance of the relationships of meanings among technical terms is obtained based on a correlation among the technical terms as a result of the statistical analysis. This distance is then converted to relative locations on a plane. Ultimately, the technical terms are plotted on a map in terms of the locations on the plane's coordinate axes. At the same time, with respect to document data such as patents and research papers, relationships with technical terms are analyzed, and locations are determined in such a format that document data are gathered around implicative terms. These document data are then plotted on the same plane.

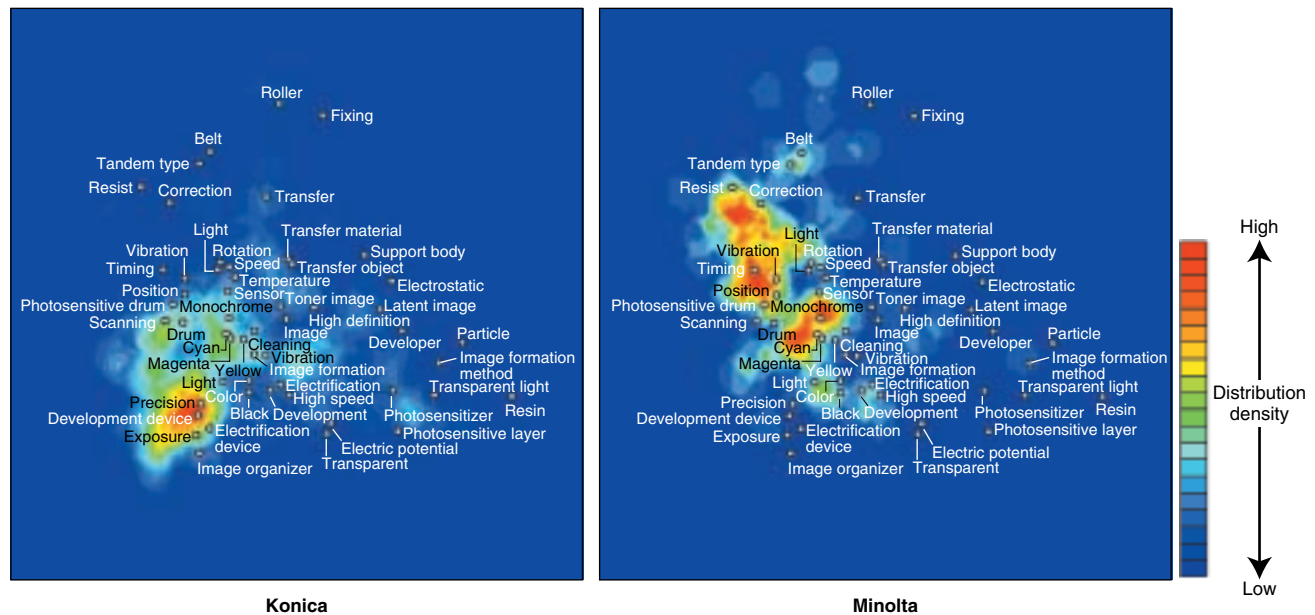
The Technology Heat Map calculates the distribution density of document data plotted on the plane by means of the prescribed rules, and expresses the density gradation by color (Figures 5 and 9). The red portion indicates a high document data distribution density meaning that document data are concentrated there.

The features of the Technology Heat Map include the following:

- (1) The technical terms and document data that are plotted are expressed based on relative locations (the distance of the meaning relationships) and do not have a meaning of absolute locations.
- (2) Technical terms with similar meanings are plotted close to each other.
- (3) The more unique a term is, the farther the term appears from the center.

**Figure 5. Examples of Technology Heat Map Analysis (Merger of Konica and Minolta)**

As a result of the business consolidation of Konica and Minolta, Konica acquired technologies owned by Minolta, which was strong in copiers, to supplement its technologies.



Note: To determine the population of the analysis, a search was made by using the keywords of "color electronic photos (F term '2H030') + "high speed" included in the document.

- (4) Because the analyses are based on language, this method can be applied to all technology fields without limiting the technology sectors.
- (5) Since the analytical results can be compared and expressed by resolving them into various categories that are included in the population of the analyses, they are effective for comparisons with competitors and in time-series comparisons.

Figure 5 shows the case of applying the Technology Heat Map analysis to the patents concerning color electronic photos of the former Konica and the former Minolta with respect to Konica Minolta that was created after their merger in August 2003. In this map, the greater the patent distribution, the stronger the reddish tinge. Accordingly, this map indicates that the former Konica acquired patent groups of the former Minolta, which was strong in technologies related to color machines, and that business consolidation was implemented in the format of supplementing technologies.

With respect to investment for R&D, the number of companies that consider the procurement of technologies from the outside instead of adopting the conventional method of developing technologies within their own company is increasing. The company's business strategies include a growth strategy to enter new fields, a modification (reinforcement) strategy to cover the company's weaknesses and a modification (selling) strategy to review departments generating low profits. In any of these strategies, a company is required to conduct studies from the perspective of an intellectual property portfolio in selecting a target company for merger or to which a relevant department is to be sold.

As shown in Figure 5, conducting the Technology Heat Map analysis from the perspective of an intellectual property portfolio enables the examination of the effectiveness of business consolidation or the determination of the direction of such a business consolidation. Specific questions involved in this analysis include whether business consolidation can supplement mutual technologies, whether business consolidation can lead to a monopolization of technologies if technologies owned by the companies are overlapped or whether double investment requires review. As such, the above intellectual property portfolio analysis and evaluation method can also be an effective means for building a strategic intellectual property portfolio.

### III Examples of Analyses Using the Technology Heat Map

#### 1 Intellectual Property Portfolio and Efficiency in R&D

The following section uses the cases of four copier manufacturers to analyze the efficiency of R&D by means of the above analytical method and based on the disclosed patent information and financial data.

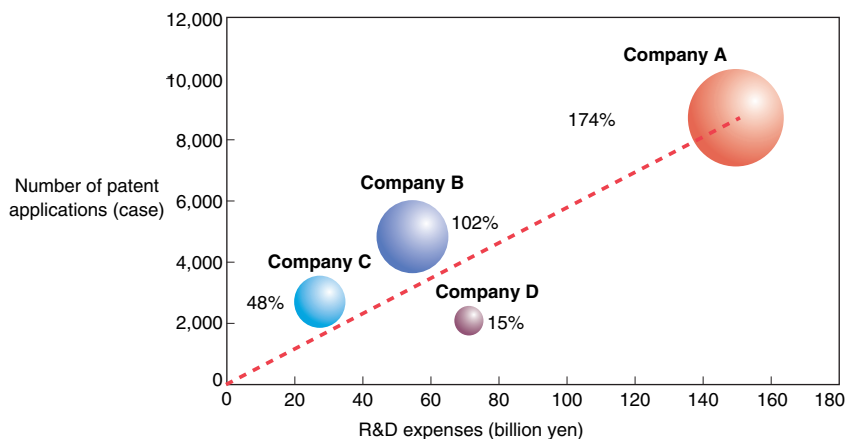
Figure 6 reveals that Company A has been actively investing in R&D and surpasses the other three companies in both sales and operating profits. Company A also ranks at the top in terms of R&D efficiency, which is calculated by dividing the operating profits by the costs for R&D. However, the ratio of the number of patent applications to expenses for R&D is higher in Companies



**Figure 6. R&D Efficiency of Four Copier Manufacturers**

**R&D expenses and its efficiency**

	Sales (billion yen)	Operating profit (billion yen)	R&D expense (billion yen)	Number of patent appli- cations (case)	R&D efficiency (%)
Company A	1,646.0	259.8	149.5	8,766	174
Company B	793.3	55.7	54.6	4,907	102
Company C	353.4	13.0	27.2	2,772	48
Company D	648.9	11.1	71.3	2,105	15



Notes: (1) R&D efficiency = operating profit/R&D expense. (2) The average values for fiscal 1993 through fiscal 1997 are used for R&D expense and the number of patent applications. The average values for fiscal 1998 through fiscal 2002 are used for sales and operating profit. (3) The size of a circle in the lower graph indicates R&D efficiency.

Source: Compiled based on financial data announced by each company.

B and C than that of Company A. PPM analysis and Technology Heat Map analysis were conducted to explain this phenomenon.

These analyses were made by limiting the target population to the specific technology field of inks (F term <patent classification code> “2C056-FC01”). While overall evaluation requires similar analyses with respect to other technology fields, it is possible to infer the following based on the analytical results.

The PPM analysis indicates that Company A’s portfolios are concentrated in the high share portion even though there are a large number of patents in total. A balance is maintained between the acquisition of technologies ahead of others (the portion of patents falling under the “spearheading and monopoly” category) and the acquisition of peripheral patents (the portion of patents falling under the “catch-up and peripheral” category) (Figure 7). These findings reveal that the company’s technologies were successfully held as a result of filing patent applications in the specific technology field ahead of other companies and progressively filing applications for peripheral patents as well.

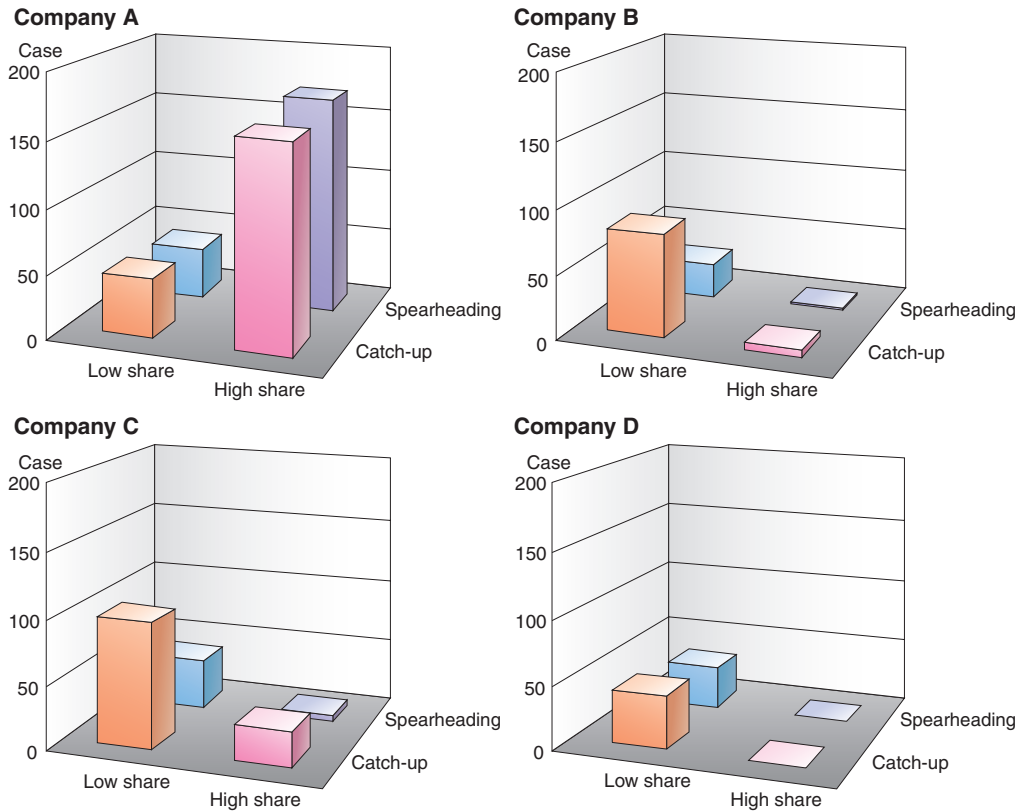
Moreover, the Technology Heat Map analysis indicates that the technology fields in which patent applications were filed by each company overlap in many portions. However, with respect to technologies for which Company A is taking the lead, this analysis indicates that Companies B, C and D are not exploring new technology fields and/or are unable to file patent applications efficiently (Figure 8).

As stated previously, the disclosure items of intellectual property reports that some companies started to publish this year primarily consist of those indicating the relationships between R&D and business operations. The content of these reports announced thus far is limited to merely giving qualitative descriptions of focused fields with respect to R&D segments and the direction of business operation strategy, and includes no specific figures such as what percentage of R&D investment is devoted to what field. Use of the above intellectual property portfolio analysis and evaluation method in creating such reports will enable further clarification of a company’s business operation strategy.

## 2 Intellectual Property Portfolio Related to Mobile Communications

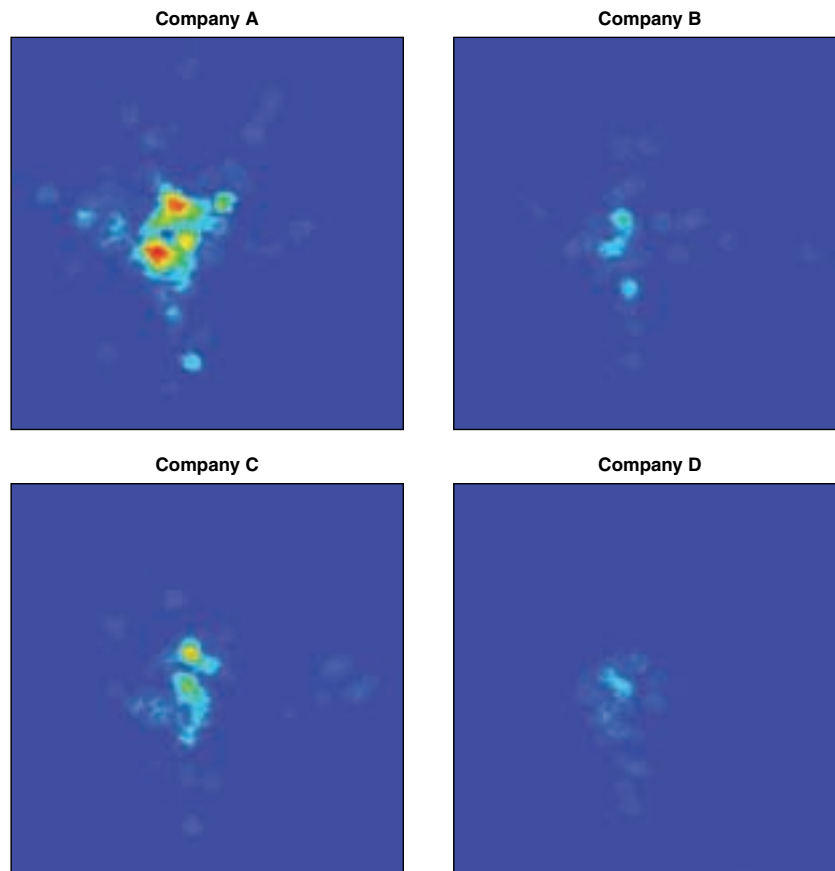
Recently, from among the patent applications in a variety of fields, the number of applications in the IT (information technology) field has been increasing rapidly. These patents, which frequently involve many applied inventions, are known for their difficulty in understanding the technical terms used and in conducting analyses. In particular, with respect to fourth-generation mobile phones and IP (Internet protocol) communications that make up a major part of the key technologies used in the ubiquitous network, it is important to clearly understand the current status of R&D in order to prepare future R&D strategy.

**Figure 7. PPM Analysis of Four Copier Manufacturers**



Note: Search was conducted by using the keyword "ink" (F term "2C056-FC01") to determine the population of the analysis.

**Figure 8. Technology Heat Map Analysis of Four Copier Manufacturers**



Note: Search was conducted by using the keyword "ink" (F term "2C056-FC01") to determine the population of the analysis.



**Figure 10. Technology Heat Map Analysis for Mobile Phone Company E**

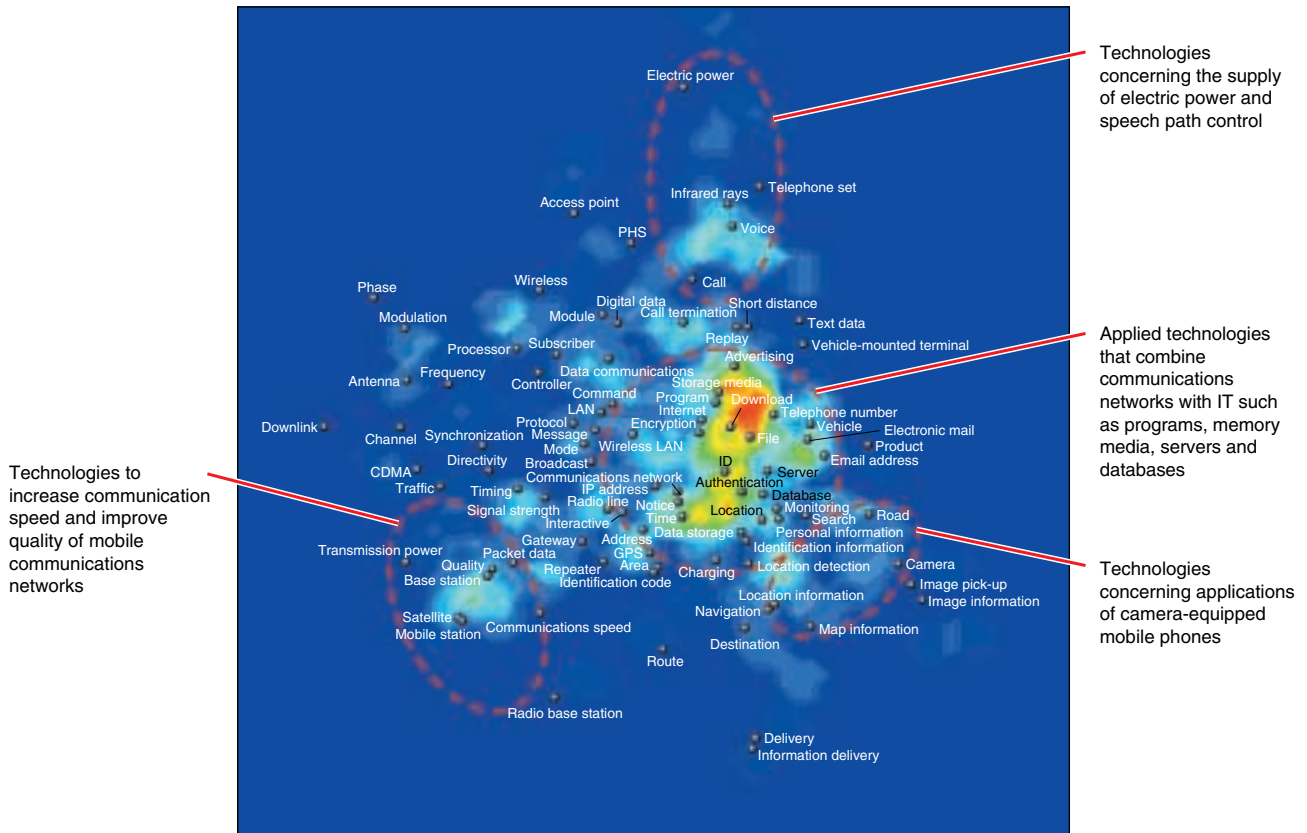
**Portfolio of patents concerning "mobile communications + IP communications" (147 patents)**



Note: IPC 'H04B7' (wireless transmission systems) and terms in which "IP" and/or "Internet" are included in the keyword.

**Figure 11. Technology Heat Map Analysis for Electric Appliance Manufacturer F**

**Portfolio of patents concerning "mobile communications + IP communications" (226 patents)**



Note: IPC 'H04B7' (wireless transmission systems) and terms in which "IP" and/or "Internet" are included in the keyword.



## IV Toward the Formulation of Future R&D Strategy

### 1 R&D Strategy in Industry, Academia and Government

Since the latter half of the 1980s, R&D investment in the manufacturing industry has started to exceed capital investment. This fact has invited two different interpretations. One is that the results that can lead to capital investment have not yet been achieved through R&D; the other is that a company has been improving its plant productivity by making use of the plant substitution effect generated by R&D.

From either of these perspective, there is no doubt that the formulation of a company's R&D strategy and its intellectual property strategy is becoming a much more important process in forming a clear view of the future core of a business.

In particular, organizations that have an interest in the management of R&D and intellectual properties in Japan are not limited to companies. This matter also has a significant impact on the degree and type of cooperation between industry, academia and government. For example, since 2001, national research institutes have become independent corporations one after another. These research institutes are beginning to increase their focus on emphasizing R&D strategies and intellectual property strategies that are aimed at commercialization. Furthermore, in April 2004, national universities have begun transformation into independent administrative corporations, and intellectual property headquarters have been established at 34 major universities. As such, moves have also emerged in educational organizations to redefine the concepts of R&D.

### 2 Expanded Use of Technology Heat Maps

As stated previously, the essential purpose of the Technology Heat Map analysis discussed in this paper is to "link the space of enormous corporate financial data and the space of intellectual property data" by employing the latest information processing technology under an environment where progress results from the disclosure of various kinds of information.

Technology Heat Map analysis can be applied not only to patent specifications written in Japanese but also to those written in English. Accordingly, this methodology can serve as solutions that are useful for formulating a company's global R&D and intellectual property strategies as well as for increasing cross-border transactions.

Moreover, the targets of Technology Heat Map analysis are not confined to intellectual properties centered on patents. This analysis visualization is also applicable to intellectual assets such as research papers before a patent application is filed. For example, it would be useful to

have an extensive understanding of the latest R&D trends of fuel cells by plotting related research papers before filing a patent application on an intellectual property portfolio consisting of patent applications concerning fuel cells.

### 3 Formulating Strategy Including the Perspective of M&A

When accounting for asset impairment, which is to be introduced by some listed companies in fiscal 2005, is implemented, and when M&A by means of the exchange of foreign stocks is approved by amendment to the Commercial Law in 2006, a number of cases of large-scale business restructurings and mergers involving foreign capital companies is expected to occur.

The introduction of accounting for asset impairment is expected to generate the effect of promoting sales of a company's idle assets including intellectual properties. For example, in the case of business restructuring, technologies owned by a company are identified in its portfolio, and Technology Heat Map analysis is used to visualize the strength of those technologies. This will be an effective means as a promotional measure for companies that have an interest in accepting technology transfers.

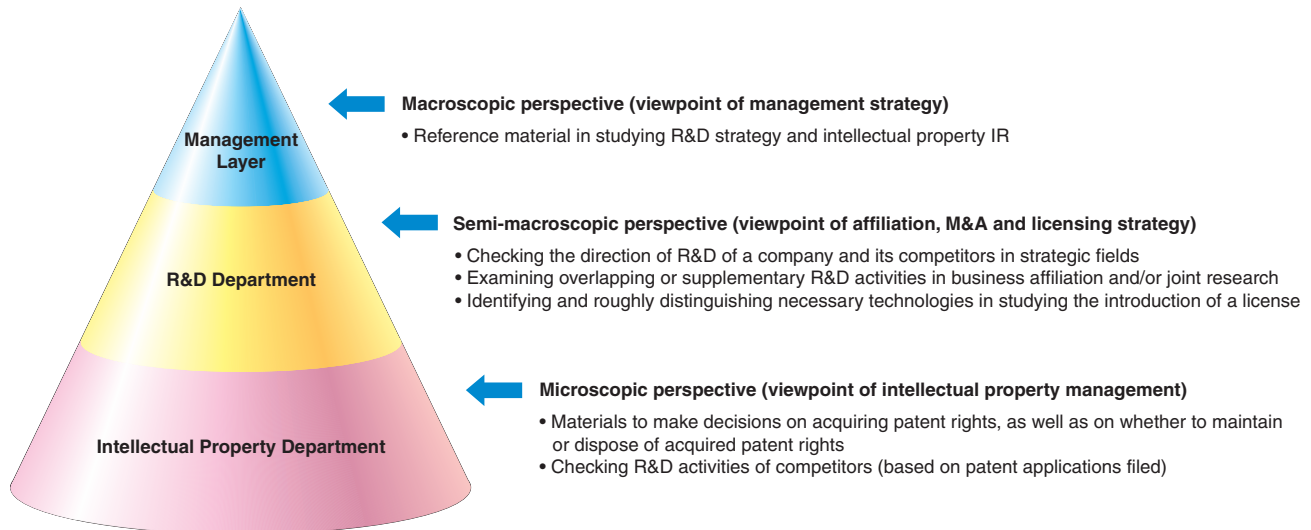
The same effect can also be expected in the case of M&A. As was shown in the example of Konica Minolta, the effect of technological integration can be visualized and explained to management and investors in an easy-to-understand manner. This could help a company select a list of companies having specific technologies that would supplement the core competence of the principal company and narrow down candidates as subjects for negotiations.

In examining M&A, due diligence (careful prior examination of the target business for acquisition) is an important process. In the past, financial and legal specialists conducted close examination of potential business risks. However, prior examinations of intellectual assets that have a major impact on the evaluation of business value had not been conducted. In formulating future strategies that also include an M&A option, it would be useful to implement careful prior examinations concerning intellectual properties by using the solutions discussed in this paper.

### 4 Vitalizing the Operation of Intellectual Properties

In order to build an intellectual property strategy through the combination of business and R&D strategies, information concerning intellectual properties should be shared by management, an R&D department and an intellectual property department. The business strategy and the R&D strategy should be formulated through their close cooperation. It is important to link



**Figure 12. Operation of Intellectual Properties and Information Sharing (Necessity for a Common Language)**

these measures to corporate management focusing on intellectual properties as the core. However, as noted previously, while the demand for R&D is increasing in the face of global competition, many Japanese companies do not yet have sufficient in-house financing capability or profit-earning ability necessary to meet such a demand.

The Technology Heat Map developed by NRI is one solution proposed by NRI. This map plays a role of providing a common language for people who recognize the importance of sharing information regarding the operation of intellectual properties. At the same time, the application fields of this map are expected to expand substantially in accordance with user needs (Figure 12).

We look forward to the use of these solutions in diverse fields, and hope these solutions will contribute to vitalizing the operation of intellectual properties in Japan.

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