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Research on a Technological Evaluation Method Applying Patented Invention for Strategic Technology Management

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Abstract--Patent value is defined and described from the following 3 aspects; market value, legal value and technological value. There have been done several researches regarding market value and legal value of patents, but no specific researches on technological value of patents, which can be evaluated from patented invention. The technological value is essential to give strong impacts on its market with long life cycle of the product. In case there is a high inventive step, it will not be easy for competitors to catch up to produce the similar products. However, in case with small inventive step, it will not be leading product. This research focuses on a specific product field; stent, with two major manufacturers Cordis and Terumo, and proposes a technological evaluation method with technological leveling, applying multi-variate analysis to extract the specific technological features of the said manufacturers competing each other to establish their own superior field as a result of their own R&D activities. The point for technology management is how to produce a breakthrough product having a high technological value. Based on the proposed evaluation method, the technology can be properly evaluated to give essential information for decision making of strategic technology management.

I. INTRODUCTION

By seeing cycle of intellectual creation [2], it is known that in order to turn the cycle of intellectual creation to expand business, it is necessary not only create intellectual properties and get intellectual property rights, but also utilize them after create and/or get it. About the utilization, there are many kinds of way to utilize [4] [6]. For example, using intellectual properties and intellectual property rights by ourselves, let others use our intellectual properties and intellectual property rights, etc. By using intellectual properties and intellectual property rights by ourselves, it is possible to monopoly all market and get more profits. But if the inventive step is too low, it is also possible that we will be catch up by others easily, so to monopoly the market is difficult. So the technological value of patented invention will affect how easy it is to monopoly market. By using business

and law evaluation methods, it is almost impossible to evaluate the technological value of patented invention, so technological evaluation method is necessary.

And it is also possible to get royalties, increase partner and expand market by letting others use our intellectual properties and intellectual property rights. The calculation of royalties of patented invention will be affected by the value of patented invention, so the technological evaluation is necessary.

II. THE PURPOSE OF THIS RESEARCH

There are many evaluation methods, but almost of them are business and law evaluation methods, only IPScore [1][4], which is technological evaluation method, was found.

The cost approach, the market approach and etc. are known as business evaluation method; and the range of claim, remaining time of rights, and YKS method [3] and etc. are known as law evaluation method.

III. THE TENDENCY OF PATENT APPLICATION ON STENT FIELD

In order to accomplish this research, we focus on the products which have fewer parts, fewer competitors, and target end users, so we can understand the technological features, grip market situation.

There are many technologies which satisfy aforementioned condition, but we would chose and focus on the stent [5] [7] which is one of medical instruments and still no technological evaluation method of it.

By searching "stent" at abstract and claim on the Japan Industrial Property Digital Library (IPDL) website, we know that Cordis group and Terumo Corporation lead at this field as it was shown in Fig. 1, so we chose the two corporations as target.

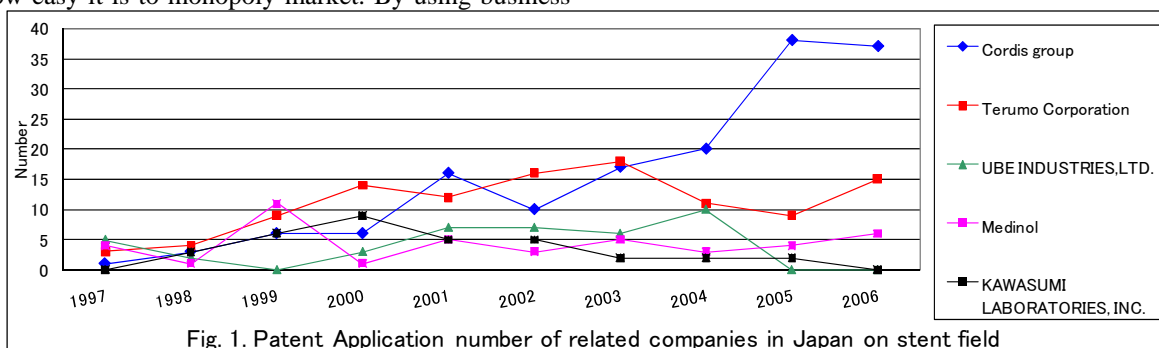


Fig. 1. Patent Application number of related companies in Japan on stent field

So called stent can be used to many parts of human body, for example blood, urethra, etc. In this research, we focus on the stent which is used to prevent restenosis of blood. So we found 62 patents/patent applications for Terumo Corporation and 84 patents/patent applications for Cordis group by

searching at IPDL website using the condition shown at Table 1.

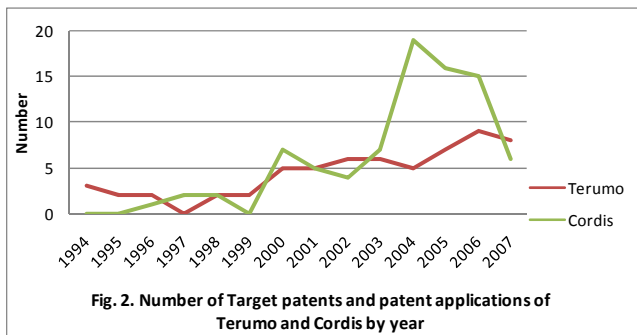
After classifying patents/patent applications of Terumo Corporation and Cordis group, we got the result shown at Table 2.

Search Engine	Japan Industrial Property Digital Library (IPDL)
Gazette Type	Published patent application, Examined patent application publication
FI	A61M29/00 & A61M29/02
Applicant	Terumo Corporation/Cordis group
Application date	1994/01/01~2007/01/01
Target technology	blood stent
Rejected patent applications and patent applications whichl are deemed to have been withdrawn are not included	

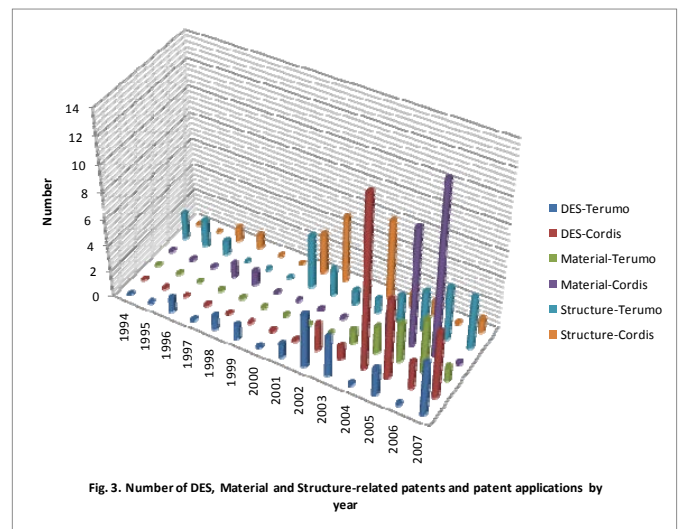
	Terumo	Ratio (%)	Cordis	Ratio (%)
Total	62	100	84	100
Stent structure	26.0	41.9	19.0	22.6
Cure branch	4.0	6.5	3.0	3.6
have cover	5.0	8.1	3.0	3.6
DES	16.0	25.8	29.0	34.5
Material	11.0	17.7	26.0	31.0
Positioning	0.0	0.0	3.0	3.6

From Table 2, it is known that the stent structure-related patents/patent applications made up almost 42%, and the Drug Eluting Stents (DES)-related patents/patent applications made up almost 26%.

In another way, from Table 2, it is known that the Drug Eluting Stents (DES)-related patents/patent applications made up almost 35%, and the material-related patents/patent applications made up almost 31%. And we also classified all target patents/patent applications of Terumo Corporation and Cordis group by application year (if priority date exist, the year of priority date), as shown at Fig. 2.



And then we also searched the application year of DES, material and structure-related patents/patent applications, as shown at Fig. 3.



From fig. 3, we can know that patent applications were not much before 2000 and the two corporations are not so different. But after 2001, they were quite different.

The difference is that, about DES-related applications, Terumo Corporation filed more earlier than Cordis group, but they cannot continue to file after 2000.

Even Terumo Corporation filed DES earlier than Cordis group, they still cannot sell DES right now. In contrast, Cordis group filed DES-related applications at 2002 but get the right to sell DES (Cypher stent) at 2004.

About structure-related applications, the two companies filed almost the same time and continue filing, but Terumo Corporation files more and more applications these years. In contrast, Cordis group files less and less. During 2003~2006, Cordis group filed quite a lot of applications, and DES and material-related applications made up very high ratio.

IV. PROPOSAL OF TECHNOLOGY EVALUATION ANALYSIS PROCESS AND RESULT OF ANALYSIS

A. Technology Evaluation Method

By preliminary survey which using technological and law

term, we know that each patent (technology) of the two companies got different point by technological evaluation term. In contrast, different point did not show by business term. This means that the difference between patents/patent applications (technologies) can be measure/evaluation by using technological evaluation method. In contrast, it cannot be measure/evaluation by using law evaluation method. For this reason, technological evaluation term was used in this research.

This research was done according to the process shown at Fig. 4.

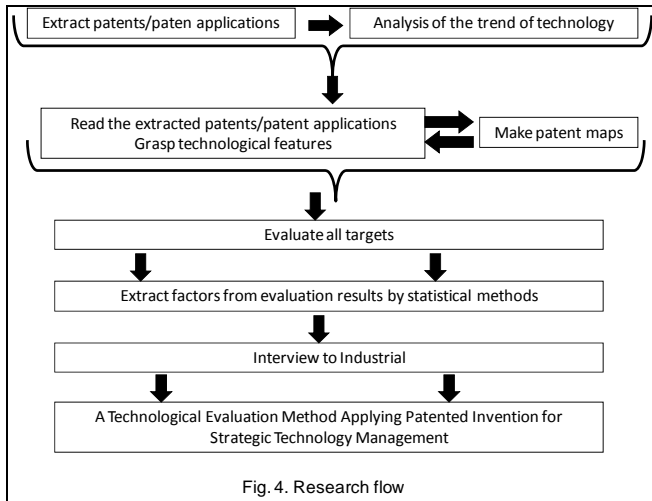


Fig. 4. Research flow

The targets of this research are patents/patent applications of the stent which is used to prevent restenosis of blood. After

extracting targets, analysis of the trend of technology was done. Then, the extracted patents/patent applications were read so the technology could be understood and technological features can be grasped. According to technological features, technological evaluation terms and patent maps of the two companies were made for better objectivity.

Then, targets were evaluated from 1 point to 4 points by using extracted technological features and patent maps. The targets which got 4 points are “new technology” relatively to published patents/patent applications (technologies) when it was published. The targets which got 3 points are “the technology which is not new but was written in claim of patents/patent applications and can get good effects by using it” when it was published. The targets which got 2 points are “the technology which is not written in claim of patents/patent applications but could be used and get good effects by using it” when it was published. The targets which got 1 point are “not related technology”.

After evaluation, factors were extracted from evaluation results by statistical methods. The purpose of the factor extraction is to analyze R&D strategy which can be read from patents/patent applications.

B. Result of Technology Evaluation Analysis

1) Patent Map

After reading extracted patents/patent applications, technological features were extracted and patent maps were made for better objectivity.

Fig. 5 is the patent map of Terumo Corporation. They were divided into 4 fields and trends of them were grasped.

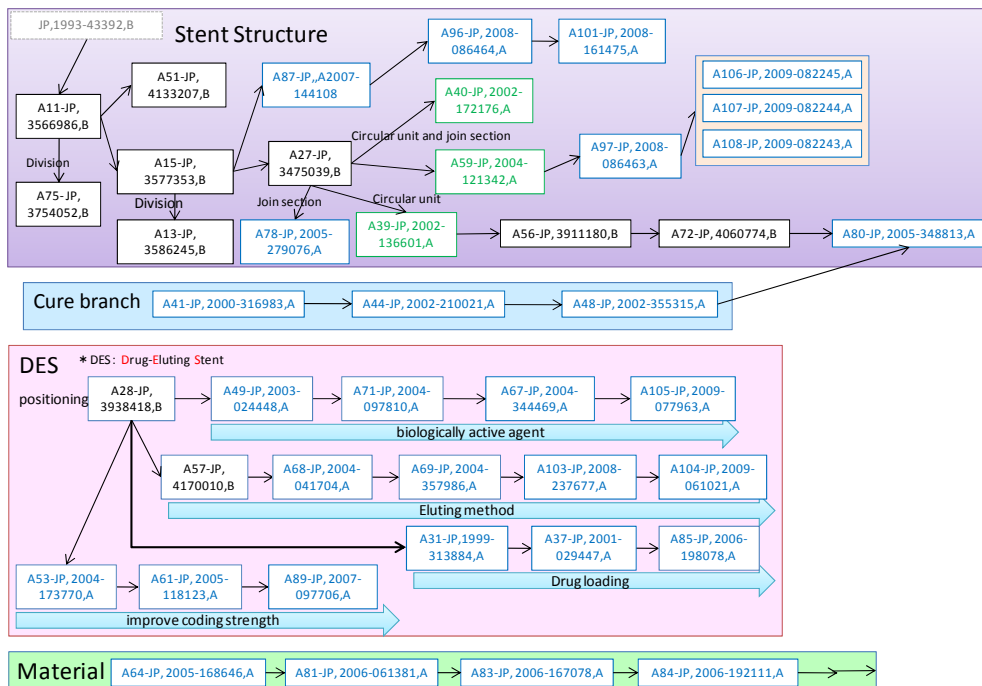


Fig. 5. Patent Map of Terumo

3) Further Analysis

Material, strong radial force, stent structure and coding filed were chosen from the technological features of the two companies. In order to measure the strength of the two companies at the 4 fields, the total score which sum all

patents/patent applications score by field and year was introduced as one method to measure. The result was shown at Table 5.

The shifts of 4 fields were shown at Fig. 7~10.

Table 5: Shift of total score of 4 technological topics

Corporation	Technological Topic	Year:	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Terumo	Material		33	22	22	0	22	22	55	55	66	66	55	77	99	88
Cordis			0	0	5	15	10	0	35	25	20	35	95	98	157	60
Terumo	Strong Radial Force		12	8	16	0	12	12	35	26	35	35	29	58	74	58
Cordis			0	0	8	24	16	0	67	55	39	72	245	263	240	96
Terumo	Stent Structure		33	29	30	0	28	29	81	79	100	104	100	143	171	171
Cordis			0	0	8	27	25	0	86	64	57	95	287	256	225	98
Terumo	Coding		39	26	26	0	26	26	65	69	101	111	97	148	207	175
Cordis			0	0	29	87	58	0	203	145	126	222	820	802	804	348

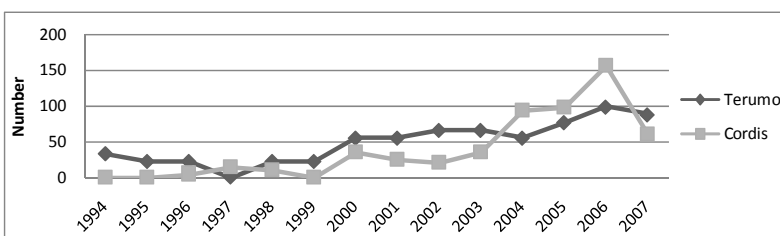


Fig. 7. Shift of total score of Material-related patents and patent application of Terumo and Cordis

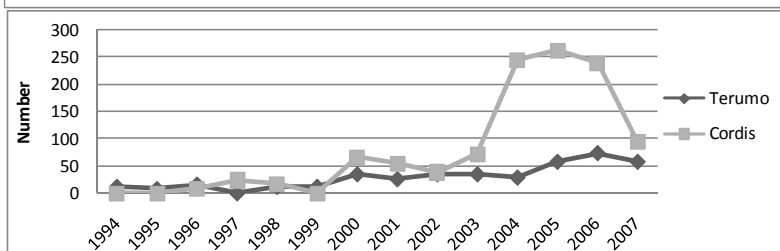


Fig. 8. Shift of total score of Strong Radial Force-related patents and patent application of Terumo and Cordis

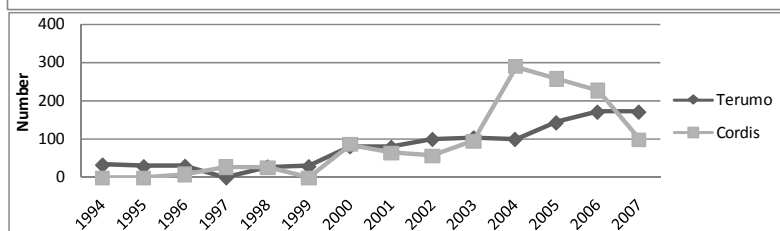


Fig. 9. Shift of total score of stent structure-related patents and patent application of Terumo and Cordis

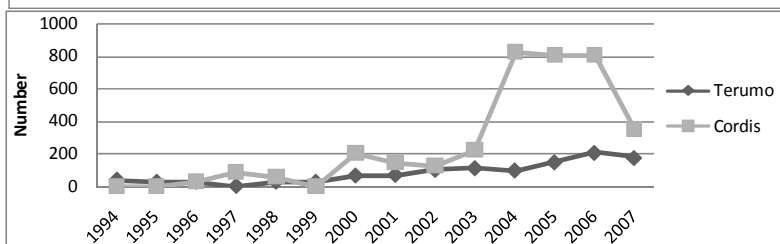


Fig. 10. Shift of total score of Coding-related patents and patent application of Terumo and Cordis

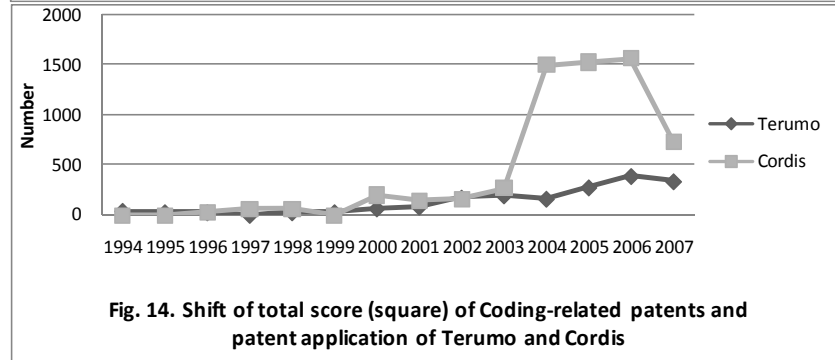
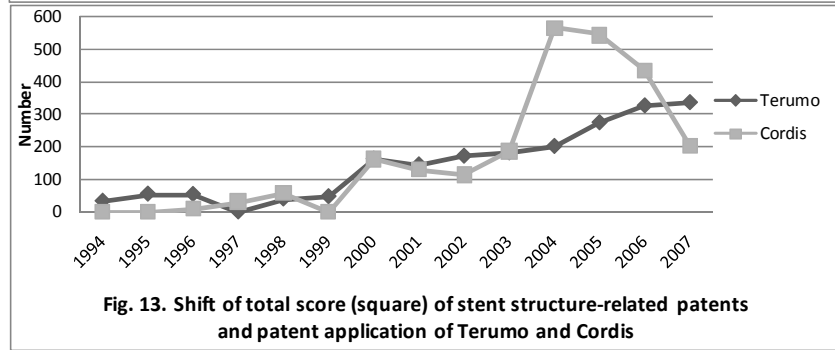
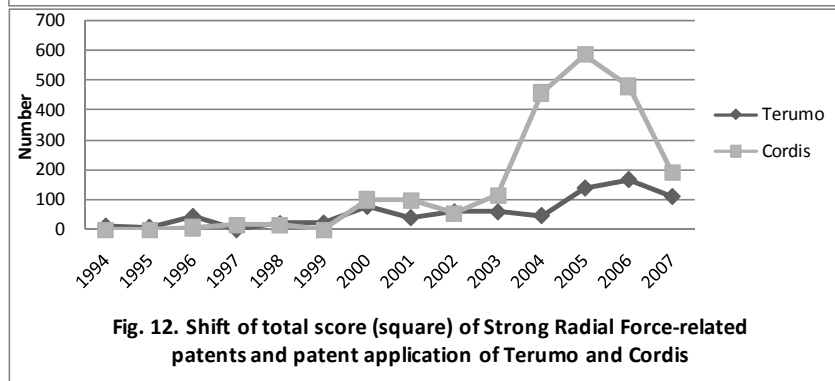
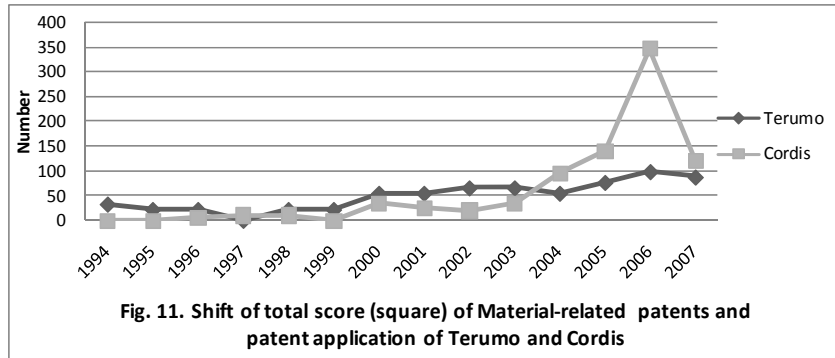
From Fig. 7~10, it was known that Terumo Corporation continues to file in all these 4 fields.

Before 2000, it was not so different between the two companies, but during 2004~2006, Cordis group filed a lot of applications so the score of Cordis group increased significantly besides of material field.

According to Fig. 7~10, it was found that the score was

affected by the number of patent applications significantly, so we doubled all score before sum them to try to reduce the affection by the number of patent applications.

In other words, 4 points patent/patent applications were counted as 16, 3 points patent/patent applications were counted as 9, 2 points patent/patent applications were counted as 4 to made Fig. 11~14.



By comparing normal figures and doubled figures, it was known that only the result of material filed changed. In other words, Terumo Corporation filed more than Cordis group but Cordis group got higher scores in material field.

the difference between scores of the two companies is meaningful or not. SPSS (15.0.1J (22 Nov 2006)) was used to *t*-test.

Table 6 shows all results. About the average of the score of “material” ($t(857)=2.11, p<.05$) and “stent structure”($t(442)=11.61, p<.01$), Cordis group is higher than Terumo Corporation.

4) *t*-test

Another measure method, *t*-test, was used to verify that

	Terumo		Cordis		<i>t</i> value
	Average	Standard Deviation	Average	Standard Deviation	
Strong Radial Force	1.72	0.69	1.74	0.61	-0.40
Material	1.25	0.55	1.33	0.55	-2.11 *
Stent Structure	1.36	0.57	1.85	0.53	-11.61 **
DES	1.47	0.61	1.51	0.61	-1.75

** $p < .01$ * $p < .05$

5) Factor Extraction

a) Factor Extraction 1 (Patent Application between 1994 ~ 2003)

In order to analyze R&D strategy which can be read from patents/patent applications, factor extraction was done.

Use SPSS (15.0.1J (22 Nov 2006)) to extract factors from technological features and evaluation results (points) of targets which were filed from 1994 to 2003.of the two companies under the condition shown as Table 7 and got

factors shown as Table 8.

Factor extraction method	unweighted least squares
Assignment of number of factors	5
Rotation method:	Varimax with Kaiser Normalization
Number of iterations	25
Minimum absolute value to cut	0.4

	Terumo Corporation	Cordis
1st factor	DES	Circular unit
2nd factor	Basic structure (flexibility and bearing resistance)	joining section
3rd factor	Do not stress bolld out	prevent restenosis
4th factor	Structure (do not get stuck on blood)	loading
5th factor	prevent restenosis and get flexibility by coding	Structure (do not get stuck on blood)

From the result of factor extraction, we found that Terumo Corporation focused on DES from that time.

b) Factor Extraction 2 (Patent Application after 2000)

We did factor extraction again but targets were filed after 2000 under the condition shown as Table 9 and got factors shown as Table 10.

Factor extraction method	unweighted least squares
Assignment of number of factors	Terumo:6, Cordis:7
Rotation method:	Varimax with Kaiser Normalization
Number of iterations	25
Minimum absolute value to cut	0.4

	Terumo Corporation	Cordis
1st factor	DES (Drug Eluting control)	DES (type of drug)
2nd factor	Material	DES (Drug Eluting control)
3rd factor	DES (flexibility)	Material (polymer and drug)
4th factor	Structure (opening section)	circular unit
5th factor	join section (wave-shape)	Structure (do not strain under stress)
6th factor	join section (skew)	join section
7th factor	N/A	Structure (can be filled with drug)

From the result, the DES appears many times and at high priority, so we know that both of the two companies focused on the DES after 2000. But if we see more detail, the sub-fields were different.

Maybe the reason is that because Cordis group, a subsidiary of Johnson & Johnson, is a comprehensive medical company, so that can do drug research. In contrast, Terumo Corporation is a medical device maker, so they cannot do drug research so they tried to develop the way to elution and other added-value research.

Then, we also found that both of the two companies focused on material field. Maybe the reason is that the stent which are made of stainless cannot decompose in human body but remain in human body and bring after-effects. So new material which decompose in human body can prevent after-effects. We guess it will be the next hot field in stent world.

C. An Interview to Industrial

Purposes of interview are A): know the situation of evaluation system in stent field; B): get advices/comments about evaluation method and term done in this research. Then we interviewed the Intellectual property division of a company which is doing R&D, manufacturing, selling of stent. Results listed below were obtained.

- 1) *To know the situation of evaluation system in stent field:*
 - a) They have their own evaluation system which includes business term (the possibility to license/cross license, potential, life of technology, etc.) and law term (novelty, inventive step, the range of claim, etc.), and they evaluate by points and total points.
 - b) When evaluating patents/patent applications, intellectual property division and R&D division work together. If necessary, marketing division also join.
 - c) The patent map done by this research classified technologies well and grasped the trend of stent technology well.
 - d) One shortage of this research is that it takes time. If this process can be done by computer, it will be better and can use to more and more different fields.
 - e) After the filing of patent applications, it usually takes one and half year to let publish to the world. In other words, the time lag exists. So it is necessary to join conferences which are usually held after filing but before publishing to get latest news.
 - f) The result of factor extraction represents the feature of the two companies well.
- 2) *To get advices/comments about evaluation method and term done in this research:*
 - a) It is better to put "the range of claim" term into evaluation term.
 - b) About evaluation method, it is better to classify the purpose of invention and then compare their claim by

the purpose of invention.

- c) They really want the evaluation method which has certain field-specialized evaluation terms.
- d) To classify patents/patent applications by purpose, using the prior arts referenced by examiner is one easy and correct way.

V. CONCLUSION

Even the necessary of technological evaluation methods is known, but it did not be proposed until now. So we tried to propose a technological evaluation method which differs by fields and chose stent field. At first, we narrow out target companies and patents/patent applications. Then tried to understand stent technology, grasped the trend of stent technology, made patent maps and evaluated targets. In order to know their strength and weakness of the two companies, we chose 4 relatively important fields to compare them. Moreover, in order to know that the difference of mean values of the two companies is meaningful or not, *t*-test was done.

Furthermore, in order to know factors which can be read by patents/patent applications, in other words, in order to know what important technologies are, how technologies transit, the factor extraction was done. So we tried to propose technological evaluation method in stent field and also heard opinions directly.

One future task is to make proposal to R&D from the evaluation of technologies. Concretely, use results of the technological evaluations to grasp the power relationship of related companies in stent field. And then put the power relationship into SWOT analysis to, for example, develop strategy which applies the technological strength with other strengths to get chance and exclude threats. By the same way, develop strategy which overcome shortages or cover shortages by strengths, and do not give chance away.

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