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Gains and pains from licensing: Patent-portfolios as strategic weapons in the cardiac rhythm management industry

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Nr. 497

Gains and Pains from Licensing

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Patent-Portfolios as strategic weapons in
the cardiac rhythm management industry

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I. Introduction

Because of the rapidly growing number of elderly people, products for the treatment of cardiac rhythm disorders are a major part of the US \$ 130 billion medical device market. Since 1994 two US companies dominate the pacemaker segment. Very interestingly, the two competitors show substantially different developments of their financial performance. While Medtronic, Inc. reports increasing returns, St. Jude Medical, Inc. exhibits performance declines (see Table 1).

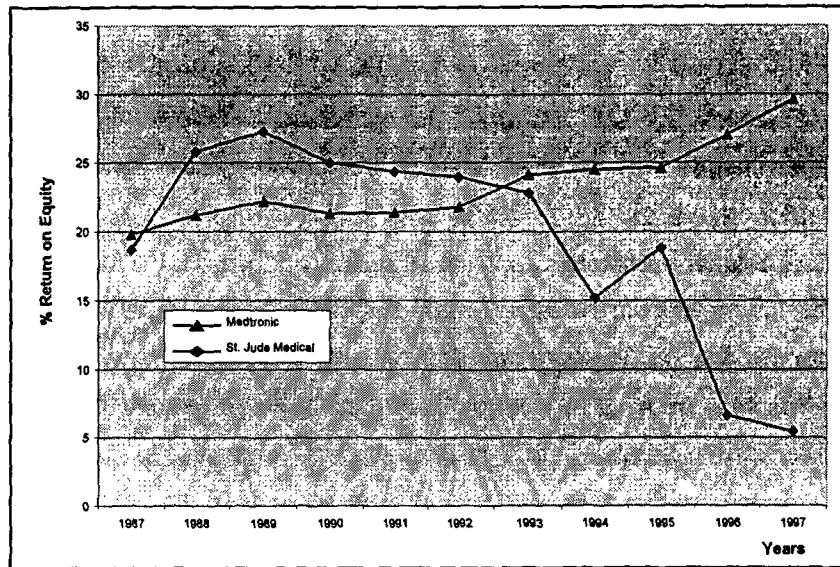
Table 1: Selected Business Data for Medtronic, Inc. and St. Jude Medical, Inc., 1987-1998

Year	Medtronic, Inc.			St. Jude Medical, Inc.		
	Sales**	Net Earnings as Percent of Net Sales	Earning per Share	Sales**	Net Earnings as Percent of Net Sales*	Earning per Share
1987	515,4	14.6	0.15	71,8	24.1	0.40
1988	669,9	12.9	0.18	114,1	29.3	0.71
1989	765,8	13.1	0.22	148	34.4	1.07
1990	865,9	13.0	0.24	175,2	36.9	1.35
1991	1.021,4	13.1	0.28	209,9	40.0	1.75
1992	1.176,9	13.7	0.34	239,5	40.7	2.12
1993	1.328,2	14.8	0.41	252,6	28.7	1.07
1994	1.390,9	16.7	0.51	359,6	18.5	1.70
1995	1.742,4	16.9	0.64	723,5	13.8	1.12
1996	2.172,1	19.7	0.90	876,7	6.9	0.66
1997	2.438,2	21.7	1.11	994,4	5.3	0.58
1998	2.604,8	17.6	0.98	-	-	-

Source: Annual Reports; Medtronic's fiscal year runs from May to June (e.g. 1997/1998), St. Jude Medical's Annual Reports are based on the calendar year; * corrected for the most recent reporting in the case of St. Jude Medical, Inc., where earlier reports show higher returns on sales; ** total sales (not only pacemakers).

Figure 1 shows impressively that St. Jude Medical's return on equity dropped from 23% in 1993 to 5.4% in 1997, whereas Medtronic's return on equity increased from 24% to almost 30% during the same time period.

**Figure 1: Development of Return on Equity:
St. Jude Medical vs. Medtronic (1987-1997)**



Source: Annual Reports.

The different developments, and in particular those that occurred at St. Jude Medical's since 1994, are most remarkable. The question arises, what could have caused these developments? Company histories might give a clue. Therefore, we want to review very shortly the most recent history of the two companies, and a third player which is of particular interest, Siemens AG, the US \$ 70 billion German conglomerate. Information is taken from Annual Reports and Internet presentations of the companies.

II. Company Portraits

(1) Siemens AG

It is reported that a Swedish subsidiary of Siemens AG (Siemens-Elema AB, Solna) developed the first implantable pacemaker in 1958, and the first endocardial pacing lead for long-term implantation only a few years later. While these are major achievements, almost nothing is learned about them in the Annual Reports of Siemens. Medical technologies sold at approximately DM 3 billion in the 1985/86 fiscal year. Although no details about product categories are published it is safe to assume that pacemakers did not account for more than US \$ 150 million. This explains why the annual reports of Siemens did not specifically refer to the bradycardia pacing segment. Nevertheless, in 1985, Siemens acquired the US company Pacesetter, probably not for technological reasons but as a market entry support to North America. Reports in the years after 1987 show substantial sales growth for medical technologies. However, pacemakers are mentioned only in passing in the 1987/88 and the 1990/91 reports. Return on equity of Siemens-Elema (which includes more than the pacemaker business) is reported since 1987 (see Table 2). In the last year of reporting, Siemens-Elema achieved sales of DM 546 million, which were down from DM 624 million in the preceding year.

Table 2: Return on Equity (%) for Siemens-Elema AB, 1987-1993

Year	Return
1987	33.2
1988	12.3
1989	9.4
1990	36.2
1991	22.4
1992	20.6
1993	29.4

Source: Siemens Annual Reports

In September of 1992, Siemens settled out of court a four year long patent infringement case that was started by Medtronic, Inc. In the 1993/94 Annual Report Siemens mentions having sold the pacemaker business as per September 30, 1994 at a price of 792 Million DM. This contributed 344 Million DM of after tax profits to overall profits, which helped to stabilize its profit before taxes at the level of the preceding year. In another section of the Report it is argued that the development of the single product pacemaker market into a cardiac vascular system's business would have forced Siemens to acquire a substantial amount of external know-how and was therefore the reason for dissolving from this unit. In addition, Siemens

would have to invest overproportionally into R&D after losing the patent suit against Medtronic. In the following years, sales and – more substantially - profits of the medical technologies section seem to suffer from the sale of the pacemaker business.

It is difficult to understand why Siemens sold a profitable unit. Was there a strategic problem? This might perhaps be discovered by looking at the acquirer and potential competitors.

(2) Medtronic Inc.

When Medtronic was founded in 1949 as an electrical service and repair company for electronic medical appliances in the Twin Cities Area, one could hardly have envisioned it as a producer of the first battery powered external pacemaker that was invented by one of the company's officers in 1957. Earl E. Bakken, one of the founders, described Medtronic's future in 1989 by the following statement: „Our plan is to grow with technologically sophisticated, physician-prescribed, therapeutic products for the cardiovascular and neurological markets, and that's the direction I see the company taking in the future. Despite all the progress, there is still plenty to do in the cardiac and neurological therapies and in combination of both fields“ (Annual Report 1989, p. 7). The company claims to be the world's largest producer of implantable pacemakers. Reports on patent infringement suits both against the Company and of the Company against its competitors are mentioned frequently in the Reports (Table 3).

One of these cases, the Eli Lilly case, was settled out-of-court in 1991. The settlement provides for a cross license of all patents covering cardiac stimulation devices that electrically manage the rhythm of the heart and includes an agreement under which the company will supply certain bradycardia pacing products to a subsidiary of Lilly for a defined period of time. Another cross-licensing agreement was reached in 1991 with Cardiac Pacemakers as the result of litigation, and in 1992 with Ventritex, leading to royalty payments from Ventritex.

Yet another battlefield becomes visible from reading the notes to the consolidated financial statement in the 1992 Annual Report. The management reports: “In the company's ongoing patent infringement litigation instituted in January 1988 against Siemens-Pacesetter, Inc. and its parent, Siemens Elema AB (collectively, “Siemens“), the United States District Court for the Northern District of Illinois ruled in September 1991 and in February 1992 that the Sensolog, Sensolog III, and Synchrony pacemakers infringed the activity rate responsive patent of the company. The court issued injunctions prohibiting the manufacture, use, and sale of these pacemakers in the United States, and the company is seeking damages for past patent infringement. The court also indicated that a trial would be required to determine whether Siemens' Synchrony II and Solus pacemakers infringe this patent. Although a trial date has not yet been set, the company has filed an action in the U.S. District Court for Minnesota seeking injunctive relief and damages with respect to these two pacemakers. All actions by

the Illinois court have been repealed by Siemens ... In March 1992, the company filed suit in the U.S. District Court for Minnesota claiming infringement by Siemens of eight of the company's patents. This suit includes the Synchrony II and Solus infringements. In March and April, Siemens filed suits against the company in Los Angeles claiming, among other things, that the patents cited in the Minneapolis case were not valid and not infringed, that the company violated certain anti-trust laws, and that the company is infringing certain Siemens' patents. The company intends to contest these allegations" (Medtronic, Inc., Annual Report 1992, p. 45).

Table 3: Patent litigations involving Medtronic, Inc., 1980-1994

Year	Suit against Medtronic	Suit against competitor
1980		<i>Intermedics</i> : patent infringement
1983		<i>Intermedics</i> : patent infringed; court ruling <i>Intermedics</i> : patent infringed; confirmed by court of appeal
1986		US \$ 7.3 mill. Plus future royalties from patent infringement law suits
1988	<i>Eli Lilly</i> : US \$ 26.5 mill, certain market restrictions until 1990.	<i>Intermedics</i> : US \$ 39.2 mill. from patent litigation settlement <i>Siemens</i> : name not explicitly mentioned in annual report
1989	<i>Eli Lilly</i> : continued (appeal)	
1990	<i>Eli Lilly</i> : continued (appeal)	
1991	<i>Eli Lilly</i> : Out-of-court settlement; cross-licencing agreement.	
1991/ 1992	<i>Siemens</i> : Counter Suit	<i>Cardiac Pacemakers</i> : Cross-Licencing <i>Ventritex</i> : Cross-Licencing, royalty from Ventritex <i>Siemens</i> : first reference to law suit to shareholders in the Annual Report 1992 (first rulings in Medtronic's favor already in 1991)
Sept. 1992		<i>Siemens</i> : Litigation settlement; cross-licencing; intial payment by Siemens of US \$ 50 mill.; significant royalty payments by Siemens (prepayment of US \$ 25 mill.); Medtronic pays no royalties.
1994		<i>St. Jude Medical</i> : Acquisition of Siemens-Pacesetter under terms of former litigation settlement.

Source: Medtronic, Inc. Annual Reports

Quoting Medtronic's superior patent portfolio, the company reports that a settlement of the patent litigation cases with Siemens was reached in September 1993. The earnings statement shows a cash inflow of US \$ 50 million. But this can be only part of the settlement. It is reported that Siemens will make ongoing royalty payments for approximately ten years based on Siemens' sales of all cardiac stimulation devices. Medtronic also receives cross licenses

from Siemens without a payment. Siemens made a contingent prepayment of US \$ 25 million for future royalties. As of April 30, 1995, this prepayment had already been fully recognized. In the 1995 Annual Report readers are informed that by 1994 St. Jude Medical, Inc. had acquired the Siemens pacemaker business, and would make the royalty payments that Siemens had agreed to make.

(3) St. Jude Medical, Inc.

The company was founded in 1976 to develop, manufacture and market medical devices for cardiovascular and vascular applications. It developed soon into one of the world market leaders of heart valves. The position of a Vice President for Technology was newly created in 1988. R&D expenditures began to grow beyond the 5% level at that time. The aim was to become a broadly based medical products company. World-wide activities were started in 1990. Pyrolytic carbon-coated components for heart valves were bought from Carbomedics, Inc. by a long-term contract. A new supply agreement covered the period from 1990 to 1998. Carbomedics also received royalty payments from St. Jude Medical's which enabled the company to produce its own heart valve component sets, however at a limited scale.

It appears that the distribution network was not developed on a global scale at this time, as the company licensed certain parts of its developments to a supplier who paid a royalty on the basis of sales in countries where St. Jude Medical had patent protection but obviously no personal sales organization. Direct sales became a much used distribution vehicle since 1989, shifting away from distributors. At about the same time the company received authorization from U.S. regulatory agencies to utilize certain parts of the components it had developed in products for domestic sale. This had been expected since quite some time, as the carbon components had been sold in many other developed countries.

With its relatively low R&D expenditure St. Jude Medical seems to have concentrated on becoming independent of its primary supplier. In fact, it received FDA approval to use its own carbon components in 1992.

More growth was generated from a "diversification" program that led to a substantial number of acquisitions (see Table 4). Only one divestiture is reported in 1996, which did not affect the core business of the company. Key personnel was attracted from competitors, among them the CEO who has led the company since 1993. The 1993 Annual Report describes at great length the steps taken in the diversification planning process.

A most important acquisition was made as of September 30, 1994: St. Jude Medical bought the pacemaker activities from Siemens. This left a number of significant traces in its economic performance. R&D expenditures were almost doubled, a non-cash charge of US \$ 40 million for ongoing R&D that was purchased but should be treated as an expense was made, and a price of between US \$ 511 and US \$ 531 million had to be paid. Both companies disagreed about the final purchase price, the same could be observed in some other future

acquisitions. Net sales rose from US \$ 110 million to US \$ 360 million, however, they would have almost stagnated without the acquisitions. To finance the acquisitions, a new credit line had to be established. However, it is reported in 1995 that half of the debt incurred to acquire Pacesetter had been repaid by the end of fiscal year 1994. This is remarkable when taking into consideration that the R&D spending level reached 9.5% of sales. The Annual Reports in the following years report on the substantial efforts to reorganize Pacesetter and to integrate it into St. Jude Medical's organization. This took longer and more effort than anticipated. Pacesetter and Ventritex were merged into the St. Jude Medical Cardiac Rhythm Management Division in 1997. Again, non-cash purchased R&D charges and charges to resolve patent disputes together with the cost of integrating the various acquisitions had to be carried by the company during the following years.

Besides the cost of acquiring and integrating new companies, it should be borne in mind that Pacesetter owes licensing fees to Medtronic, Inc. (see Table 3). The St. Jude Medical Cardiac Rhythm Management Division claims to own about 900 patents in 1998.

Table 4: Acquisitions made by St. Jude Medical, Inc., 1993-1997

Year	Company
1993	InControl, Inc. Telios Pharmaceuticals, Inc. (Electromedics, Inc.: Acquisition process terminated)
1994	Advanced Tissue Sciences, Inc. Pacesetter/Siemens
1995	Heart Valve Comp
1996	Daig Corp. Teletronics Pacing Systems, Inc. Medtel Biocor Industria E Pesquisas Ltd.
1997	Ventritex, Inc.

Source: St. Jude Medical, Inc., Annual Reports

III. Patent Analyses

Medtronic's long record of mostly successful patent litigations against major competitors indicates that a strong patent position can be a very effective competitive weapon in this industry. After the settlement of its major patent suit against Siemens, (which ended in favor of Medtronic), Medtronic's board of directors wrote to its shareholders: "In our Bradycardia Pacing Business, fiscal 1993 was highlighted by two achievements...., the settlement of the patent litigation with Siemens in September was significant financially, strengthening our returns to shareholders and allowing us to increase our investment in research and development, including new ventures. This settlement could not have happened without Medtronic's superior patent portfolio." (Medtronic, Inc., Annual Report, 1992, p. 2). As mentioned above, St. Jude Medical also refers to its intellectual property assets in its annual reports. To shed more light on the respective positions, patent analyses in the international market for pacemakers were performed.

Patent data were searched in the WPINDEX database which covers patents filed in all major countries including patent applications at the European Patent Office (EPO) and via the Patent Cooperation Treaty (PCT). We chose a combination of relevant International Patent Classifications (IPC) and keywords in order to define the technological field of pacemakers appropriately. Technical expertise was provided by industry experts to finalize the search strategy. Taking into account lags between the first, priority securing patent application, its publication and its accessibility in the database, we analyzed patent data until the year 1995.

Figure 2: Patent Applications in the Field of Pacemakers (1965-1995)

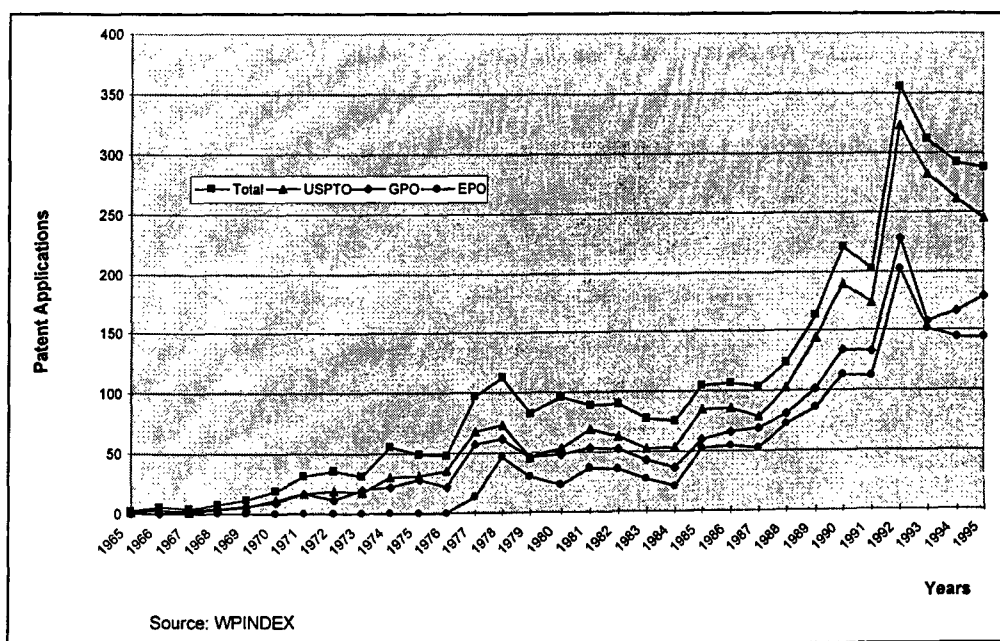


Figure 2 displays the development of annual applications for pacemaker patents between 1965 and 1995. The total number of patent applications is broken down by applications at the US Patent and Trademark Office (USPTO), at the European Patent Office (EPO) and at the German Patent Office (GPO). We can observe an almost parallel development of patent applications at the different patent offices over time. The US market seems to be of great importance for pacemakers since most of the patents are filed at the USPTO. The overall trend indicates three phases of patenting activity. First, patent applications rose steadily from the 1960s to the second half of the 1970s. After reaching a first peak in 1978, patent applications decreased slightly and then remained basically unchanged for almost ten years. Starting in 1987, patent applications increased exponentially during the following years and peaked at a number of more than 350 patent applications p.a. in 1992. This indicates the dynamic technological developments in the field of pacemakers in recent years. The decline of patent activity since 1992 might be attributed to a general decline of patent applications caused by the economic slowdown in many parts of the world. Certainly, the field has not been harvested completely as indicated by the recent growth surge of patent applications, especially at the GPO.

Let us now turn to patent activities of individual competitors. First, we found that St. Jude Medical did not file patents in the field of pacemakers prior to the acquisition of Siemens-Pacesetter in 1994. By 1998, St. Jude Medical had filed 49 patents, mainly in the field of heart valves, its core business before the acquisition of Siemens-Pacesetter (Hundhausen, 1998, S. 89). Thus, St. Jude Medical's technological position in the field of pacemakers needs to be evaluated by referring to the patent position of Siemens-Pacesetter since St. Jude Medical's acquisition of this business. Since Siemens had its major R&D facilities in Europe and Medtronic is an US-based firm, we had to take measures in order to retrieve unbiased or comparable patent numbers. It is recommended to analyze patent data for international competitors at a neutral, third area patent office, as for instance the EPO (Pavitt, 1988), or to count only those patents which lead to further international patent applications (Faust, 1992). This helps to overcome the so-called "home-country-effect". Here, we used both approaches. Furthermore, it needs to be considered that Siemens had acquired Pacesetter and they appeared jointly as applicants on many patents. The resulting double counts had to be eliminated. Adding up the number of patent applications by Siemens or Pacesetter in the following figures shows their combined patent position which has to be compared with Medtronic.

Figure 3: Cumulative Patent Applications in the Field of Pacemakers at the EPO (1977-1995)

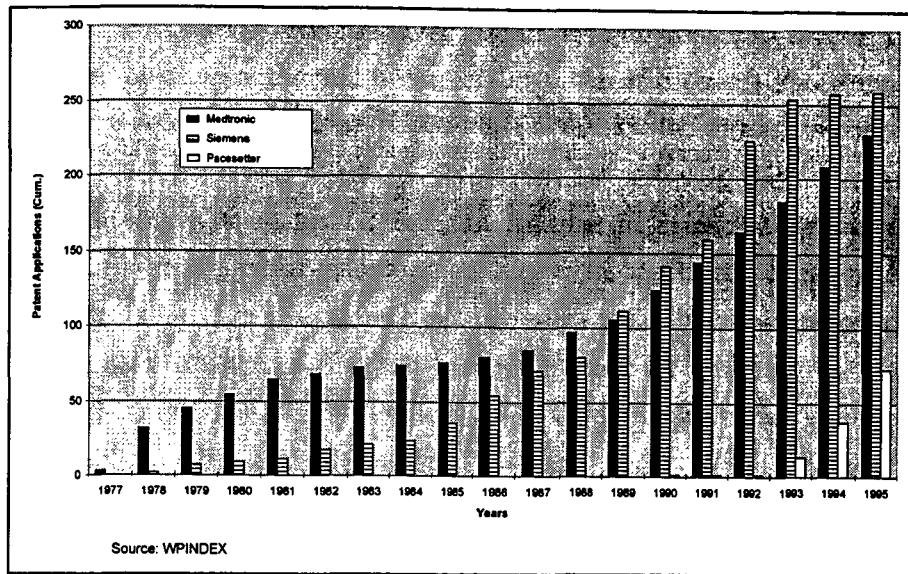
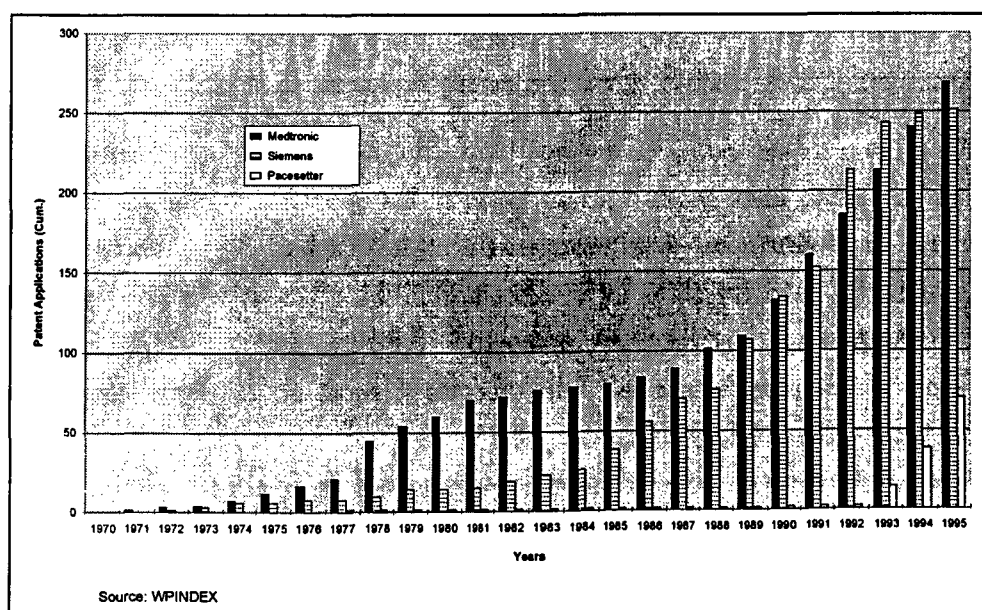


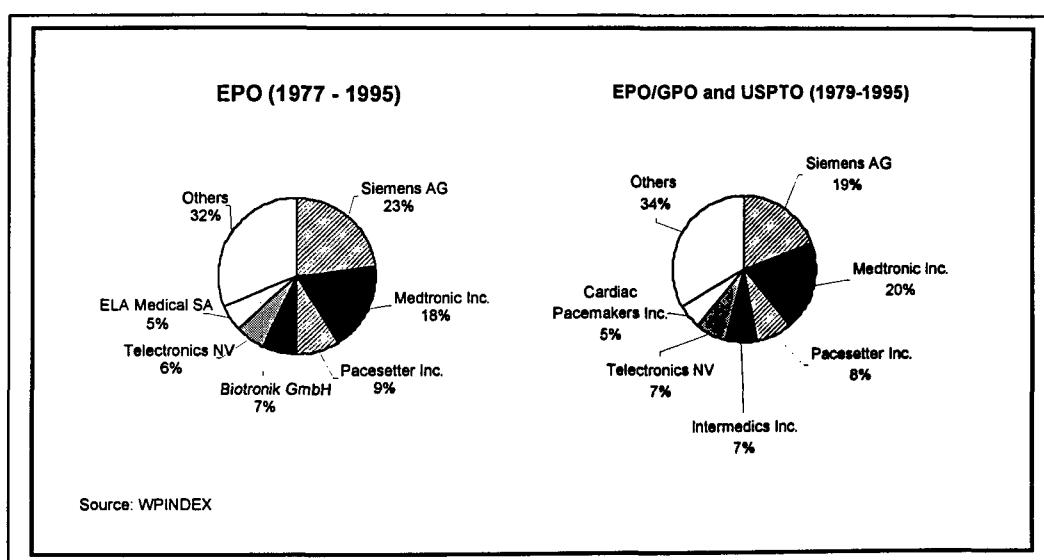
Figure 3 shows the development of cumulative patent applications for Medtronic, Siemens and Pacesetter in the field of pacemakers between 1977 and 1995 at the EPO. Medtronic filed a high number of patents already in the 1970s, whereas Siemens started filing larger numbers of patents at the end of the 1980s. In 1989, Siemens' cumulative stock of patent applications surpassed the one of Medtronic, and it remained at a higher level thereafter. Almost no new patent applications are recorded in 1994 and later. Patents of Siemens-Pacesetter are filed under the name Pacesetter after the acquisition by St. Jude Medical.

Figure 4: Cumulative Patent Applications in the Field of Pacemakers at the GPO/EPO and USPTO (1970-1995)



Analyzing patent data at the EPO may still give an advantage to European-based firms, like Siemens. Thus, and because of the importance of the US market for pacemakers, we conducted a further analysis of patents which had been applied simultaneously at either the GPO or EPO and the USPTO (see figure 4). Again, it is obvious that Medtronic built up an early strong patent position at the end of the 1970s, whereas Siemens-Pacesetter caught up to Medtronic in the late 1980s and the beginning of the 1990s. During recent years, patent applications of Medtronic and Siemens-Pacesetter are growing fast. Siemens-Pacesetter outperforms Medtronic with respect to the total number of patent applications. This can be seen by looking at Figure 5 which shows patent shares of Medtronic, Siemens and Pacesetter over almost 20 years. At the EPO, Medtronic accounts for 18% of all patent applications in the field of pacemakers whereas Siemens-Pacesetter combined account for 32%. Based on patent applications at either EPO or GPO and USPTO, the picture slightly improves in favor of Medtronic which now has a patent share of 20% compared to 27% of Siemens-Pacesetter.

Figure 5: Patent Shares in the Field of Pacemakers of Selected Companies



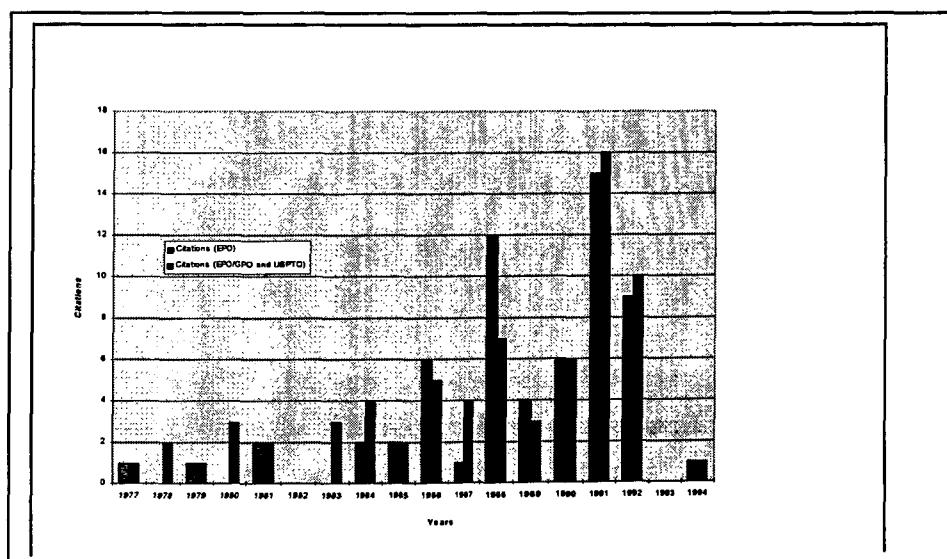
Raw patent applications data are often criticized for not reflecting patent quality. Therefore, patent applications ought to be weighted in order to get a more valid picture of companies' patent positions (Ernst, 1995 and 1998). Patent citations have frequently been identified as a quality measure of technologically and commercially valuable patents (Albert et al., 1991; Harhoff et al., 1997; Narin et al., 1987). Therefore, we retrieved the number of citations received by patent applications from Medtronic and Siemens-Pacesetter. In Table 5 it is shown that Medtronic filed a total number of 188 patents at the EPO and that these patents received 360 citations in subsequent patent applications. The citation ratio (Narin et al., 1987), which measures the number of citations received by an average Medtronic patent, amounts to 1.91.

Table 5: Patent Performance of Medtronic vs. Siemens-Pacesetter

	Medtronic		Siemens-Pacesetter	
Patent Indicators	EPO	EPO/GPO and USPTO	EPO	EPO/GPO and USPTO
Patent Applications	188	234	324	328
Number of Citations	360	413	358	367
Citation Ratio	1.91	1.76	1.10	1.13

Source: WPINDEX, own calculations

The data in table 5 indicate that the quality of Medtronic's patent applications is significantly higher than Siemens-Pacesetter's. Both citation ratios for European patent applications (1.91) and combined foreign patent applications at EPO/GPO and USPTO (1.76) exceed considerably the citation ratios for Siemens-Pacesetter (1.10 and 1.13 respectively). It is interesting to note that Siemens-Pacesetter file almost all of their patent applications at the EPO as well as at the USPTO, whereas Medtronic's patenting activity would be underestimated by looking at the EPO only. Despite its lower number of total patent applications, Medtronic's overall patent quality as judged by citations exceeds the one of Siemens-Pacesetter.

Figure 6: Citations of Medtronic Patents by Siemens in the Field of Pacemakers

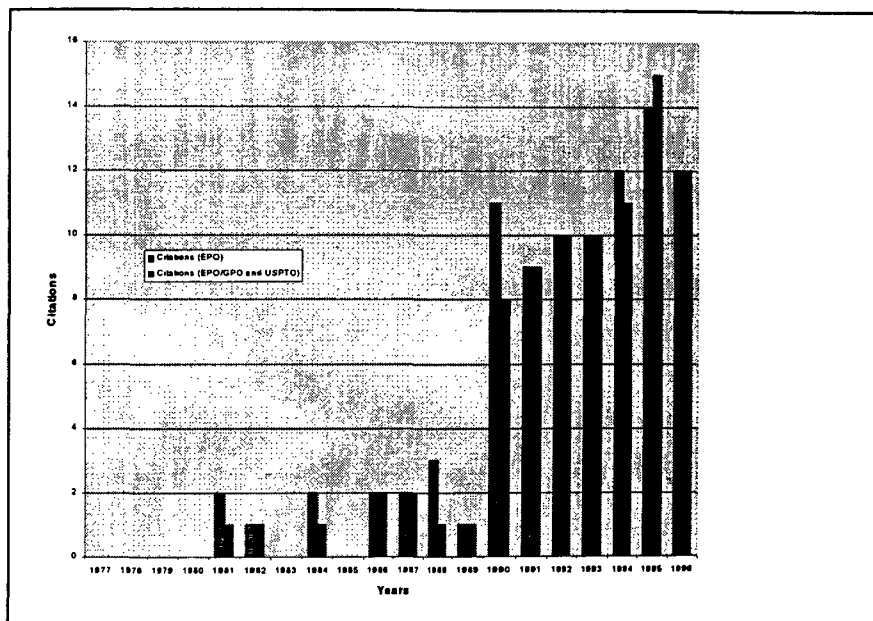
Source: WPINDEX

It is of further interest to analyze the distribution of patent citations over time. Figure 6 displays the citation of Medtronic patents by Siemens between 1977 and 1994. It is shown that Siemens' patent applications cited Medtronic's patents between 1986 and 1992 in substantial numbers. During that time Siemens had obviously increased its R&D efforts and

started filing many patents at the EPO and the USPTO (see Figure 4). It is reasonable to assume that Siemens' new patent applications cited Medtronic patents which had been filed and granted before (see Figure 3).

One may argue that the citation frequency of Medtronic's patents by Siemens mirror that the developments made by Siemens in the 1980s relied on technological know-how build up by Medtronic before. It has already been pointed out that Siemens lost the patent infringement suit against Medtronic in the US. Further citation analyses may hint at these patents which were infringed by Siemens.

Figure 7: Citations of Siemens Patents by Medtronic in the Field of Pacemakers



Source: WPINDEX

Looking at the citations of Siemens' patents by Medtronic reveals a different pattern. Prior to 1990, Medtronic had rarely cited patents held by Siemens (see Figure 7). Between 1990 and 1996, however, Medtronic suddenly started citing Siemens' patents. In view of Medtronic's law suit against Siemens it might be speculated that either Medtronic wanted to forestall countersuits by citing Siemens' patents in its 1990 to 1993 patent applications or that citations resulted from a study of material that received enhanced attention due to suits and counter suits. Later, Medtronic could freely build on the information contained in Siemens' patents since both, court ruling and litigation settlement with Siemens, set no restrictions on the use of Siemens' patents for own purposes.

IV. Discussion

Technological progress is of prime importance in the pacemaker industry. Major suppliers appear to have followed different strategies to achieve success in the market. Two of these show substantially different developments of returns. Patent analyses provide a potential explanation for this observation.

We find a very fast growth of international patent applications in the 1980s and 1990s in the field of pacemakers. This indicates that the market is of increasing attractiveness to many companies. The US market appears to be of outstanding importance with respect to market conditions and patent protection. Medtronic was the first company to build a strong patent position in the 1970s and early 1980s. Many years later, Siemens-Pacesetter increased its R&D activities and started filing large numbers of patents. These companies even surpassed Medtronic with respect to the total number of patent applications. However, patent citation analysis reveals that Medtronic's patents appear to be of higher quality than patents owned by Siemens-Pacesetter. Hence, Medtronic's patent position was getting substantially stronger compared to Siemens-Pacesetter. Medtronic's strong patent portfolio helped the company to win the patent infringement suits against Siemens-Pacesetter. Citation analysis also shows that Siemens heavily built on Medtronic's know-how which may be regarded as a further hint of potential patent infringements.

A third company, St. Jude Medical, entered the market later. At first it relied on an acquisition strategy. Its own investments in R&D were rather limited. Since acquiring the pacesetter business from Siemens major troubles have occurred. So what did St. Jude Medical get by acquiring the Siemens-Pacesetter business? The financial return figures indicate that its position has been weakened since the year of the Siemens-Pacesetter acquisition. While the acquisition might not serve as the only explanation, four observations might have contributed to the recent return slides:

1. High costs of integrating the acquisitions (which until recently Medtronic seems to have avoided for its own acquisitions)
2. Financing costs of the acquisitions (see table 6). Before 1994, St. Jude Medical had financed its business growth by equity capital only whereas the debt-to-total capital ratio rose significantly after the acquisition of Siemens-Pacesetter and has remained much higher than the debt-to-total capital ratio of Medtronic since.
3. Relatively weak patent position vis-a-vis the major competitor Medtronic.
4. Obligation to make substantial and continuous royalty payments to Medtronic that Siemens had agreed to pay.

Table 6: Debt-to-Total Capital Ratio for Medtronic, Inc. and St. Jude Medical, Inc., 1993-1998

	Medtronic, Inc.	St. Jude Medical, Inc.
	Debt-to-Total Capital Ratio	Debt-to-Total Capital Ratio
1993	10.9%	0%
1994	6.9%	32%
1995	3.4%	15%
1996	4.0%	20%
1997	6.4%	18%
1998	5.1%	-

Source: Annual Reports; Debt-to-Total Capital Ratio is defined as interest-bearing debt as a percentage of total capital.

With respect to Medtronic it will be interesting to watch whether the company will be able to maintain its excellent profit performance in the light of six acquisitions which have been undertaken since May, 1998. The two latest mergers which were executed in the fall of 1998, Sofamor/Danek, Inc. and Arterial, Inc., are both worth US \$ 3.7 billion, the largest acquisitions ever made in the medical device industry. In early 1999, substantial layoffs of personnel were announced to eliminate unexpected overlaps in the product spectrum and to reduce capacity.

In the case of Siemens one can assume that it would have most probably not sold the pacemaker business if it had won the patent infringement suit against Medtronic. This case illustrates how building a strong patent portfolio can result in a dramatic change in the structure of the cardiac rhythm industry, leaving a strong US-based duopoly. Keeping in mind the enormous costs for R&D, clinical trials and approval procedures it is doubtful that a third global player could evolve soon.

V. References

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