

# **Building Exchange Relationships, User Networks and Market Segments: Creating the Affinity Biosensor Market**

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## **Abstract**

Taking its starting point in a claim that Biacore, a pioneering Swedish producer of affinity biosensors, was “in the enviable position of creating its own market” (Abelin 1997-02-03); this paper purports to increase our understanding of market-making processes. By following in some detail how Biacore sought to build exchange relationships, user networks and market segments for their affinity biosensor, we hope to shed light on whether being in the position of creating your own market really is to be envied.

Our case study suggests that the market-making process for BIAcore, the instrument, went through three distinct phases. In the first phase, firm-centred and non-interactive, Biacore started to build a network for the new technology based on assumptions regarding the needs of the customers-to-be largely following a classic market segmentation approach. As the development of the instrument moved forward it became clear that the initially envisioned match between the instrument and the identified customer segment was difficult to achieve. The target segment for the new instrument was revised.

In the second phase, linked in time to the product launch, Biacore engaged in intensive interactions with initial users, encouraging and supporting them in developing research applications for the instrument. Being the only producer, Biacore obtained no support from competitor organisations in this processes of network creation. From these efforts emerged a number of lead users, who successfully developed interesting applications, and by doing so expanded the properties of the instrument. As the number of users grew, however, this close user-interaction became increasingly costly for Biacore.

In the third phase, linked in time to Biacore’s listing on the stock market, an effort was made to become more commercial. A number of ‘ideal’ application segments were identified using dimensions/criteria obtained from the lead users’ experiences. To support users within these segments more economically, different versions of the instrument were developed along with support routines, information material and auxiliary software. Thus, Biacore started to treat customers as groups rather than individuals, standardizing their market activities.

Our analysis suggests that the movements between micro-level activities, such as customer/user interactions, and macro-level efforts to make sense of the market situation and identify a strategic direction, was important for the company’s market-making activities. The resulting image of a market-making process passing through different stages, suggests that even transaction-based markets may have an interaction-based history. In other words, this is a “markets from networks” story.

**Keywords:** market-making; network creation; market and marketing investments; biotech.

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## 1.0. Introduction

An investment report by Enskilda Securities claimed that Biacore, a producer of affinity biosensors based in Uppsala, Sweden, was “in the enviable position of creating its own market” (Abelin 1997-02-03). The purpose of this paper is to increase our understanding of market-making processes by following in some detail how Biacore sought to build exchange relationships, user networks and market segments for a new research tool, the BIAcore affinity biosensor. As a consequence, we seek to shed light on whether being in the position of creating your own market really is to be envied, thus extending and developing existing research within IMP regarding market-making and market practice (Rinallo and Golfetto, 2006; Araujo, 2007; Kjellberg and Helgesson, 2006; Kjellberg and Helgesson, 2007).

Our theoretical starting point is the recognition, in existing literature on segmentation of industrial and business-to-business markets, that the practice of segmenting a market potentially has consequences for that market. Freytag & Clarke (2001) argue that segmentation is more than just a technique for analyzing the environment and allocating resources, suggesting that, by affecting the internal workings of the company, segmentation also “shares in shaping the environment” (ibid. p.474). Furthermore, Griffith and Pol (1994, p. 39) argue: “... some of the benefits of segmentation have not been realized due to [...] the tendency to segment markets after they have been established (at which point management becomes descriptive and reactive rather than prescriptive and proactive).” To our knowledge, however, there is little empirical research on how proactive/ex ante efforts to segment markets contribute to shape those markets.

In more general terms, the paper addresses the issue of how we can align the considerable empirical evidence generated by IMP researchers of markets being characterized as networks of exchange relationships, with the many attempts made by firms, regulators, analysts etc. to realise other versions of markets (e.g. Porterian industries, perfectly competitive markets, segmented markets). The Biacore case suggests an interactive and iterative segmentation process generating changing market segments, and indeed, multiple versions of the market for the affinity biosensor. These versions of the market varied by the different ideas of what BIAcore encapsulated: some were representations to the stock market, some were representations of a commercial / sales mentality, and still others were very much based upon interactions with individual lead user customers.

The case will be presented in three phases. These are (i) the initial development phase with an attempted segmentation ‘out of the blue’, (ii) a successful but expensive phase of user interaction for application development, and (iii) a phase of standardizing marketing and sales using an experience-based segmentation. The starting point for our analysis is the idea that efforts to segment a market may have important ramifications for a market that is “under construction” as compared to a market that is well established. Drawing on theoretical insights from markets-as-networks (e.g. Håkansson and Snehota 1995), constructivist market studies (e.g. Callon & Muniesa, 2005) and actor-network theory (e.g. Latour, 1999) we explore these ramifications in the BIAcore case in terms of buyer and seller identity, qualification of goods and mode of exchange. The transitions between the phases in the case seem to be connected to whether the objects of exchange and the buyers/users could be successfully standardized or not.

As regards the initial claim concerning the enviable position of Biacore, the case illustrates that considerable work is needed to achieve the standardization necessary for market-type transactions to be possible (cf. Araujo 2007 (forthcoming); Johanson and Mattsson 1985). Somewhat ironically, the case suggests that “thick”, interactive relations are important for achieving this. Secondly, the overall story suggests that it is perhaps not that

easy to have to carry the investments necessary to create a market on your own, not least when taking for granted users' use.

The structure of the paper is as follows. Section two below presents the methods used and the case study, organised into three phases. Following this, we discuss an analysis of the case with existing literature blended from IMP and ANT. Lastly, in the Conclusions we highlight the more general implications in terms of market creation, market segmentation and micro-macro interactions.

## **2.0. Case Study**

The research design used for the paper is that of a single case study. Knowledge claims from single cases are shaped by generalising to existing theory, as a form of 'theoretical generalisation' (Easton 1995). The case is based upon 35 face-to-face and telephone interviews conducted over an 18-month period between 2002 and 2004, supplemented with 4 additional telephone interviews carried out in summer 2006. At Biacore interviews were conducted with sales and marketing and technical staff, with both current and previous employees. A semi structured interview approach was adopted in attempting to generate data regarding the history of the development of the BIA sensor technology. Interviews with 20 users covered a mixture of innovative and follower users, located in both university and commercial settings, in the UK, Norway and Sweden. In addition, descriptive material relating to a publications database and financial data has been collected. The sources of data here include the Biacore website ([www.biacore.com](http://www.biacore.com)), along with press releases and clippings accessed through two databases for business information, the Swedish Affärsdata (<http://www.ad.se/>) and the international Factiva (<http://global.factiva.com>).

The case analysis section has been written by qualitatively mapping the Biacore-user interactions in the development of a blank resource. The first round of analysis involved a simple chronology being built, with the various interview and secondary sources marshalled into a time-based account. Several phases were then developed from this, centred upon important shifts in the account, such as a perceived need for a major restructuring exercise in preparation for a Stock Market launch. It is important to note that the case is written from the perspective of the firm, Biacore.

### **2.1. Background: Features of the BIAcore biosensor (as described in 2006)**

The BIAcore<sup>1</sup> tool combines three main features: sensor chip technology, microfluidics and surface plasmon resonance (SPR) detection.<sup>2</sup> These three features incorporate both electronic hardware and software. A target molecule is immobilised on to the sensor chip in order to measure the binding interaction between proteins, nucleic acids, carbohydrates, lipids, etc. The sensor chip is a glass surface that has been coated with a layer of gold. SPR detects changes in mass on the surface of the chip as the target molecule and molecules in a test solution interact (or not). A scientist can then follow this interaction over time via a software-generated sensorgram.

The tool embeds SPR technology that allows for analysis of protein interactions in real time, without labelling. It can be used to address four specific areas of protein interaction, namely specificity, concentration, kinetics and affinity.<sup>3</sup> The protein interaction application areas include antibody characterisation and proteomics.<sup>4</sup> Scientists can use methods such as chromatography and electrophoresis to separate and purify mixtures of proteins. A BIAcore can then be used to study the interactions between these proteins.<sup>5</sup> University laboratories, research centres and commercial organisations in life science are users of the tool, along with

commercial users in pharmaceutical and biotechnology organisations. Examples of life science research applications are the identification of DNA damage, and ‘hit’ to lead characterisation (rapid affinity ranking and detailed kinetics of interaction for small molecules binding to target proteins) is an example of a drug discovery and development application.

## **2.2. Initial development and attempted object-use segmentation<sup>6</sup> (1984-1990)**

Biacore was a project that was started in the early 1980s by Pharmacia Biotech (later Amersham Biosciences, now GE Healthcare). At the time, Pharmacia Biotech was one of the world’s largest suppliers of biotech analytical tools. Biacore’s technological underpinning is SPR technology, a light phenomenon that can be used to trace interactions between molecules. By the early 1980s, SPR was an internationally well-recognised phenomenon within applied physics. Pharmacia Biotech started to interact with one of the leading research units in this area, Applied Physics at Linköping Institute of Technology, due to the earlier experiences of one of their instrument developers. The instrument developer’s curiosity in the SPR technology inspired a project leader to consider the possibilities of utilising such sensors in a biotech tool. A small project group was established within Pharmacia Biotech, which included one of the research leaders at Linköping Institute of Technology (later on a member of the Biacore board.)

A sister company to Pharmacia Biotech, the allergy diagnostic supplier Pharmacia Diagnostics, became the main supporter of the Biacore project. They provided the first application area, along with experience regarding how to develop systems solutions for allergy diagnostics and how to relate to diagnostic labs. In addition, the Biacore project was supplied with knowledge concerning the development of system solutions for separation and characterisation of bio-molecules from Pharmacia Biotech. Thus already at a project stage Biacore was supplied with extensive knowledge related to the diagnostic analysis field.

The choice of diagnostics as the application area for the new instrument was based on a view of biosensors as a complementary technology to the existing instruments developed by Pharmacia Diagnostics. The idea was to produce an SPR-based analytical instrument, which could be used by medical personnel to analyse samples on-site, rather than sending away blood tests to a special laboratory. This meant that the price of both each test and the product itself had to be kept rather low. The production volume was estimated at 10,000 units per annum. A second, much smaller, potential market was also identified for the instrument: as a research tool for characterising bio-molecules.

In January 1987, Pharmacia announced that it had successfully secured an additional 225 million SEK (€ 25 million) from external investors to complete the biosensor-project. At this point, the total cost for the project was estimated to about 400-500 million SEK (€ 45-55 million). The product launch was planned for 1990. It was perceived that the potential market was substantial: “Biosensors are what we go in for the hardest today. If we succeed, there is a good chance of biosensors becoming our largest product ever”<sup>7</sup>.

In January 1989, with the launch of the first commercial biosensor estimated to take place within a year and a half, the diagnostics application was still put forward as an important future market for the new instrument. Pharmacia estimated that whereas the market for biosensors as research instruments was approximately 1 billion SEK (€ 110 million), the potential for biosensors in the medical diagnostics market was considerably greater, 4-10 billion SEK (€ 440-1110 million). However, it was also emphasized that the possible users in the research were “well definable and homogenous” (Veckans Affärer, 1989-01-19. Translated).

The first warning regarding the main planned diagnostics application came from relationships with customers at diagnostic laboratories. The application area was complex,

with some 60 medical conditions and at least 50 different pharmaceuticals being identified as falling within the commercially interesting part of the market. Secondly, echoing the views expressed by some diagnostic labs, the advantages of biosensors over existing measurement techniques were not as evident in this area. This was not helped by the fact that the new instrument would be expensive. Moreover, often a medical clinic is paid per test sent for analysis by the diagnostic laboratories. The latter were Pharmacia Diagnostic's main customers. Finally, the geographical market where biosensors were expected to take off first and most rapidly was the US. However, Pharmacia's position on the US-diagnostics market was weak<sup>8</sup>. Lastly, Pharmacia Diagnostics successively shifted its strategic focus away from technological diversification and business expansion, which had characterised the first part of the 1980s, and returned to the allergy diagnostics area during the second half of the 1980s.<sup>9</sup>

Whatever the explanation, the outcome was that Pharmacia Diagnostics withdrew from the Biacore project. In doing so, they essentially withdrew the diagnostic application, at least for the foreseeable future. Only a small application area would be left for the biosensor – as a research instrument for characterising bio-molecules. The question was if this restricted application ever would grow big enough to provide the young company with a sufficient user-base.

#### *Commentary: A phase of progress and flux*

Initially, two ideal users or customers were constructed as part of the Biacore project. The first represented a large group of potential customers – practicing doctors in need of diagnostic tools – with a standardised pattern of use, that of inserting a blood sample and extracting a reading. The other represented a much smaller and fuzzier group – researchers working in (large) biotechnical research labs. The chosen ideal customer for the initial phase of development was the doctor in the surgery. In line with this, the new instrument was envisioned as a complementary tool to existing equipment produced for the diagnostics application area. Several 'parent' business units were in place to generate this construction. It was hence an incremental market approach, to provide a complementary piece of kit to an existing product range. A diagnostics application to be performed in a doctor's surgery also gave the physical object a defined use and hence a set of sought after product characteristics.

At this stage, then, the project depended on the realization of a diagnostics application. While the technologies involved were not completely new, the principles of combining SPR and sensor chips for analysing interactions between bio-molecules still had to be corroborated. Only then could the details of a diagnostics application be translated into a physical device embedding the technologies. Thus, the activities in the project group initially had a clear science focus, bringing together experts from different areas, both from business units within Pharmacia and from external organisations.

A central actor during these years was Pharmacia Diagnostics, which provided the first application area through promoting the development of the tool as a complement to existing diagnostics products, and later helped to make this application area essentially impossible. This gives Diagnostics a role both in envisioning the potential market for the tool and later in removing the ideal / standardised customer on which this vision was based.

As illustrated by the final paragraphs above, a re-evaluation of the initial idealised users took place towards the end of the 1980s. This was a gradual process based on the results of the development work, indications from members of the targeted market segment, and most likely also due to Diagnostics' withdrawal. As a result, the project was redirected towards the research segment, whose customers now were characterized as "well definable and homogenous". This may of course be correct if researchers are considered as a group in comparison with other groups. The question is whether it was a relevant way of describing

them as potential customers of the biosensor instrument? At least, there is no indication of the envisioned relation between these users and the new instrument being considered.

### **2.3. Developing applications through user interaction (1990-1995)**

' "The thing that makes this work so exciting is the thought of being part of a technological breakthrough, to develop and instrument that in the future will be found in every laboratory around the world" comments Research Director Ulf Jönsson. But to succeed with the feat of placing a biosensor in every laboratory, a technological breakthrough is not enough. Pharmacia must be able to more clearly present to their customers what problems the biosensor can solve.'

(Veckans affärer, 1991-03-20. Translated).

The disappointing developments with respect to the diagnostics application had turned the whole biosensor project into a headache for its managers, its parent company Pharmacia and for the external financiers. Biacore had 90 employees, had moved into a new building, but was without any sales. Now working with a launch of the instrument to the research market in mind, Biacore employees started to develop two key application areas in order to generate an "increasing body of examples. At this time it was hard to provide convincing applications". These were characterisation methods such as epitope mapping (perceived to be the flagship application) and concentration measurement.<sup>10</sup>

Furthermore, in developing the technology Biacore had recruited many specialists from Pharmacia Biotech. These individuals were experienced in supplying scientists with tools for investigating molecular interaction. This meant that they could identify some Pharmacia Biotech customers who were reputed to be interested in new technologies. Among others, potentially interested researchers were found at the University of Leuven (Belgium), Institut de Biologie Moléculaire et Cellulaire, Strasbourg (France) and the Department of Immunotechnology, University of Lund (Sweden). These individual researchers were also able to develop some characterisation applications.

In September 1990 the first presentation of the new biotech tool occurred. This took place in Freiburg, Germany, at the site of Pharmacia Biotech's European sales office. The central issue was to demonstrate possible applications to potential users by giving "a first-hand feel for what it could do. It was real experiments with all the risks...a full exposure of the product". In-house technical staff, rather than sales people, presented the tool in a workshop format. Further, the selected Pharmacia Biotech customers were used as presenters of some first results. Similar presentations took place throughout Europe between 1990 and 1991. The potential users attending these first workshops had seen general advertising flyers describing the features of the technology. Individuals were both sceptical and had ideas in mind for new or different experiments, which were perceived to be potentially possible by combining a BIACore tool with existing techniques.

The results of experiments that were conducted at the workshops or later at Biacore's testing site were part of the sales process, alongside being included in Biacore's application files. The idea was to get this person "on our side", knowing the product, and having the ability to explain it to others. The potential user and the Biacore staff together had to engage in linking the biotech tool to a specific research project or issue: identifying a significant use or application. This occurred both at Biacore's labs and at the user's site, often for many weeks at a time. The work was frequently performed with a machine on loan from the company, prior to any sale occurring. Indeed, selling instruments was quite difficult.

On the other hand, there are indications that these early efforts of developing application areas and working in close collaboration with researchers, were made with an ulterior motive in sight:

The entire biosensor project now depends on having the technology accepted in the research world.

"This is a prerequisite for the customers in the diagnostics market to also gain faith in the biosensor technology", says Bengt Falk, CEO of [Biacore].

This faith is one reason why the launch of the next generation, a smaller instrument in the 100 000 SEK-class (€ 11 000) has been postponed until 1994.

Veckans affärer, 1991-03-20. Translated.

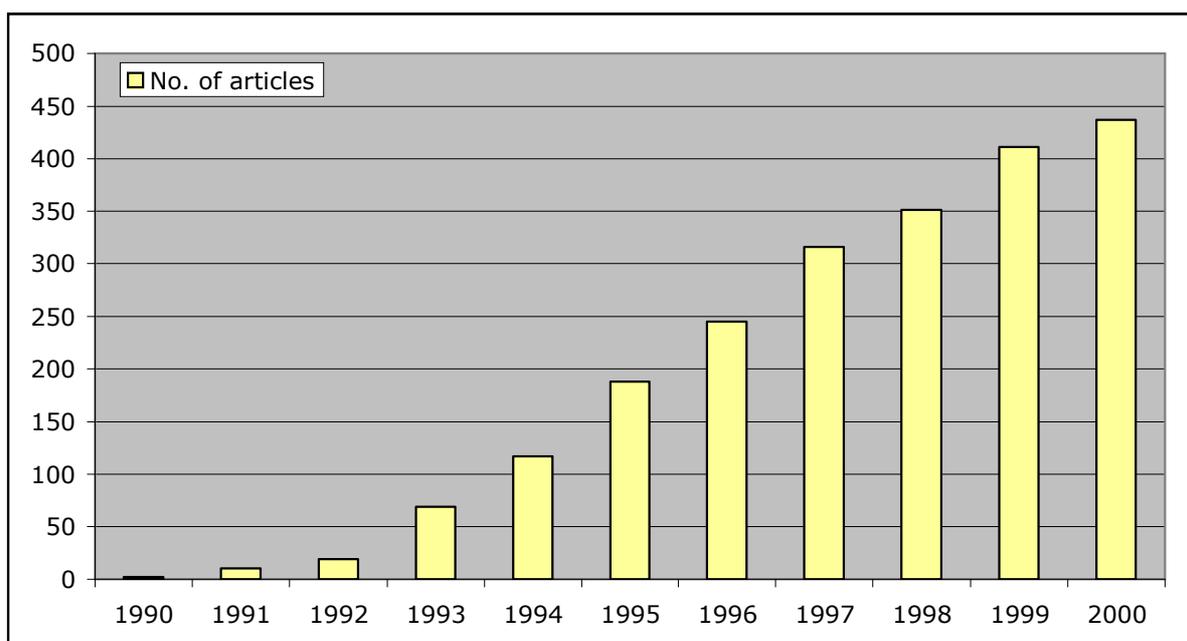
So, hopes were still nurtured about the diagnostics market. At least, this was the official version communicated by Biacore.

The after-sales process included telephone discussions of data, on-site visits and development projects. "We were very much oriented to the relationship, one-to-one interaction, being close to the users..."<sup>11</sup> This time-consuming interaction was free of charge. Indeed, Biacore developed relationships with all of the early users. As the Marketing Director explained at the time: "When a customer calls we have to leave everything we have at our hands in order to help out."<sup>12</sup>

The period after the launch also saw some formal changes in Biacore's organisation. In October 1991, Pharmacia bought out the external investors that had contributed financial resources to the finalization of the project in 1987.<sup>13</sup> Early in 1992, as part of an internal reorganisation of the group that owned Pharmacia, Biacore was moved out of Pharmacia Biotech and placed as a separate business project reporting directly to group management.<sup>14</sup> During 1992, the relations between Biacore and the marketing organisation of Pharmacia Biotech also started to change as Biacore took steps to establish its own, specialized marketing channels. Despite strong connections and considerable customer overlap between Biacore and Pharmacia Biotech, Biacore successively established its own sales forces in the UK, France and Germany, while signing distribution contracts with Pharmacia Biotech for sales in other national markets. In these markets, the qualified services, application support and demonstrations of the instruments were still handled centrally by Biacore.<sup>15</sup> Overall, these developments contributed to make the Biacore organisation more independent.

After the BIAcore instrument was 'announced' at the various workshops, different users began to apply "all kinds of different applications" encouraged by Biacore. This led to "an explosion in the literature of articles assessing the different ways of using the machine."<sup>16</sup> The early users offered feedback to the continued development of the instrument in a variety of ways, both concerning its use and its features per se, e.g. software upgrades. Further, the publications written as a result of the various experiments, in particular by users in university laboratories, started a stream of publications regarding the use of the BIAcore. Over time some of these individual researchers were becoming perceived as "key opinion leaders".

Biacore staff recorded and amassed these publications and application notes and formed a database that could be accessed by users of the instrument. As could be expected, the early articles often included Biacore staff or some of the closely connected researchers among the authors. However, the number of publications referencing BIAcore grew dramatically over the following years, and the prevalence of in-house authors decreased. By the end of 1995 more than 400 articles had been published since the first publications on the principles for immobilization and epitope mapping in 1990 (see Figure 1).



**Figure 1:** Publication of scientific articles referencing Biacore 1990-2000. (Biacore database, <http://www.biacore.com/lifesciences/service/publications/refdb/index.html>.)

Further adding to the scientific touch of their marketing approach, Biacore established the 'BIA Journal' in 1994. As one employee put it, this was "our attempt to reach out in a scientific way to new customers...it was advertising". The first issues of the journal detailed the BIA technology, testified to its importance for pharmaceutical and biotechnology research and gave considerable attention to various applications for which it could be used. Through articles prepared by Biacore staff, efforts were made to explain "the principles and scope of BIA for readers who are not familiar with the technology".<sup>17</sup>

The journal articles included research notes from Biacore staff as well as reprints of scientific publications reporting on research in which the Biacore had been used. The general idea was to bring together "interesting contributions", papers selected by Biacore employees from the reference database, or papers written on request by customers "who were doing interesting work". In all, there were 22 issues of the BIA journal between 1994 and 2005.

A second important marketing channel was established when the initial launch workshops were replaced with Biacore-organised meetings where users could present their varied applications. The first of these 'BIAsymposia' took place in 1992. For Biacore, these meetings were a place for the creation of use. For the participating users, they were "a place to talk 'real science' with others whom were using the same technology in a range of different applications...a fantastic and real discussion forum"<sup>18</sup>. For example, at the meeting in San Francisco in 1995, the application areas to be discussed by 170 delegates included immune regulation and antibody engineering. There were also presentations on how to analyse and interpret data. The BIAsymposia provided early users with a forum for discussing new ideas and meeting others, and gave new users a chance of "listening to more experienced users at conferences changed the direction of more beginner users' research". Reports from the meetings were also published in the BIA journal to increase the impact beyond the participating users. During these years, it was the users' skills in developing applications based on their existing and potential research problems that determined how the Biacore was used, and what application areas it became known for. In other words, Biacore was largely in the hands of its users.

Biacore also took measures of its own to further develop the instrument. A lower priced version of BIAcore called BIALite, to some extent born out of the original plan to concentrate on the diagnostics application, was introduced in September 1993<sup>19</sup>. However, the new instrument was far from the initially envisioned diagnostics tool. Although considerably cheaper than BIAcore, the price tag for BIALite was still SEK 100,000 (€ 11,000). BIALite was essentially a no-frills version of BIAcore requiring more manual operations.<sup>20</sup> Late in 1994, a third instrument was introduced, the BIAcore 2000, which was presented as the new flagship instrument, offering significant improvements in accuracy, speed and ease of use over the existing two versions.<sup>21</sup>

During these years, instrument sales did grow steadily as did the volume of users. Still, in June 1994 outside observers noted “major commercial success thus far has eluded biosensors.”<sup>22</sup> Despite this, the growing number of users meant that the close interaction with customers and the engagement in their problem solving processes was becoming increasingly time-consuming and costly for Biacore. Table 1 shows the high sales and administrative expenses data recorded for the first four years after the launch. As the table also shows, the operating income for the first three years was negative. It is not surprising, then, that there was heavy pressure from Biacore’s parent company to “make money and be commercial”.

Year	1991	1992	1993	1994
Sales	32.163'	52.708'	94.004'	155.496'
Product costs	-27.931'	-24.926'	-30.533'	-45.235'
Sales and administrative costs	-36.272'	-55.930'	-45.148'	-52.071'
R&D costs	-35.433'	-48.244'	-48.240'	-38.356'
Depreciations	-8.341'	-13.581'	-8.347'	-7.703'
Other revenues (costs)	1.901'	5.940'	4.089'	1.025'
Operating income	-73.913'	-84.033'	-34.175'	13.156'

**Table 1:** Costs and revenues in SEK for Biacore, 1991-1994 (Biacore prospect, 1996).

*Commentary: A phase of intensive interactions*

With attention directed towards the research segment, the high volume / low(ish) price logic was no longer appropriate. The reassessment of the potential markets for the instrument triggered a process of redefining what the instrument was (or would be). However, what these new key characteristics actually were depended on how the instrument could be linked both to other technologies in lab settings and to the specific research questions that interested potential users within the new primary target segment. Hence, the success of the project now depended on establishing working relationships with members of the targeted segment, or others that could act as stand-ins for them.

To this end, Biacore engaged in several activities geared towards associating their new instrument with others. First, Biacore employees started to work internally on two key application areas to generate examples. Second, some existing Pharmacia Biotech customers were called upon to develop some characterisation applications. Third, with the workshops and BIAsymposia Biacore created a scene for (restricted) public assaying of the new technology (Schaffer, 2007). Fourth, and related, the early users and participants at the workshops, whether sceptical or confident, provided feedback and ideas for new or different experiments. These activities transformed the instrument from a non-product, to gradually acquiring an identity as “an instrument for” certain applications. In addition, the features of the instrument were also changed in response to both ongoing product development in-house and early user feedback, e.g. new auxiliary software for specific applications.

But the interactions also configured the users and Biacore. The initial view of the members of the research segment, as being “well definable and homogenous”, clearly did not hold as they started to interact with Biacore and the instrument. Rather, what emerged from this interaction was a series of individual and unique users. Indeed, there is evidence that Biacore encouraged this development by explicitly asking researchers to develop their own unique applications. Over time, Biacore also came to perceive several of these individuals as being “key opinion leaders” regard how the instrument could be used.

As for Biacore itself, it too gained identity from these early interactions. Until the collaborations with researchers started, the project had had no real identity within the prospective market. Apart from the external technical experts and investors that had been involved in the early stages of the project, Biacore had been defined largely through its internal relations within Pharmacia. This was now starting to change through the relationships that Biacore were establishing to external actors. Although this gave Biacore an identity also outside of Pharmacia, the character of this identity seems to have remained fairly stable: Biacore remained a technology focused, problem-solving actor. Gradually, however, this too started to change. The organisational changes that took place during these years, e.g. the formal status change into a separate business project and the establishment of a separate sales organisation, reinforced the development of Biacore into a more independent actor but also indicated that Biacore was becoming more clearly a market actor.

#### **2.4. Standardising marketing and sales activities (1996-2001)**

In 1995 a new general manager was appointed to Biacore and a rationalisation project was initiated. Since there was a perceived need to improve the “market orientation” of the organisation, the rationalisation process included the sales activities. “The company saw a need to become more formal”. As sales of the BIAcore instrument increased – in September 1995, more than 400 BIAcore instruments were in use around the world<sup>23</sup> – it was considered necessary to increase the distance between the company and the new customers. The balance changed in terms of how much real time support each user received and how expensive / efficient it was to generate an experience base. In the words of a Technical Specialist: “...BIAcore was not new, lots of people had them, and non-users knew how they worked in principle...we shifted the new user to look at publications...[BIA] is an established technique and it is positioned in a research context in terms of what it can and cannot do”. In other words, assumptions were made regarding how fixed the products were, or rather, how fixed Biacore would like them to be(come).

Furthermore, in August 1996, Pharmacia & Upjohn (P&U) announced it might sell off Biosensor to investors.<sup>24</sup> This was apparently part of a refocusing exercise that was taking place at the recently merged company.<sup>25</sup> In November a prospect for acquiring shares in the company was released,<sup>26</sup> and on the 3<sup>rd</sup> December 1996, Biacore was listed on the O-list in the Stockholm Stock Exchange.<sup>27</sup> The IPO gave the new company a capital addition of SEK 160 million (€ 17.8 million), along with an additional SEK 82 million (€ 9 million) from P&U.<sup>28</sup> By the 18<sup>th</sup> December 1996, P&U reduced their stake in Biacore from 49% to 41%<sup>29</sup>. The proceeds from the sale were reported as earmarked for strengthening the distribution network and expansion into new business areas.<sup>30</sup> The prospect provides us with a view of how the market for BIAcore was perceived at the time.

Affinity based biosensor instruments belong to a specialised segment of the market for scientific analytical instruments. Hitherto the primary target group for Biacore's instruments has been the 2000-3000 largest academic, governmental and industrial laboratories that are active in basic or applied biological research. Until September 30 1996 Biacore had

delivered over 660 instruments. The price for the instruments normally varies between 700,000 and 1,600,000 SEK [€ 78,000-178,000]. Some of Biacore's customers within the primary target group have acquired several BIAcore instruments.

As part of the company's growth strategy, Biacore will also expand its product line with instruments that are more suited to the needs of a wider category of laboratories, that is, laboratories which at present are not included in the company's primary target group. If the company expands its product line in this way, an additional 5,000 to 10,000 academic, governmental and industrial laboratories for basic biological research are expected to constitute potential customers for these instruments.

In addition to a continued development of the technology for use within biological research, the company is also of the opinion that its technology may become used within a number of other commercial and industrial application areas, primarily within the food industry.

(Biacore Prospect, 1996-11-08, p.20)

The excerpt indicates that instrument sales continued to grow steadily during 1995 and 1996, with an additional 250 instruments having been sold since September 1994. The early users had developed a series of application areas, which can be broadly classified under two main headings: defining antibody characteristics and defining the characteristics of protein interactions. The former included monoclonal antibody development, antibody characterisation and the identification of therapeutic targets. In terms of the latter, disease mechanisms, drug target analysis, thermodynamic measurements and proteomics were at issue.

In the prospect, Biacore also outlined its growth strategy for the coming years, indicating four concrete ways in which Biacore would seek to expand in the biological research market: 1) continue marketing and increase penetration in the primary target group; 2) continue the development of an expanded product line with increased refinement and function both for the primary target group and other research labs; 3) increase the scope of documented methods of analysis where Biacore products can be used for analysing substances such as RNA/DNA, bacteria, viruses and complete cells; and 4) develop new application areas such as pharmaceutical screening and quality tests of pharmaceuticals.<sup>31</sup>

At this time, Biacore offered a range of three different instruments: BIAcore 2000, BIAcore 1000 (which had replaced the original BIAcore), and BIAcore X (which had replaced BIALite). Of these, BIAcore 2000 remained the flagship product, accounting for the main part of Biacore's sales during 1995 and 1996. The customers who had installed BIAcore 2000 were described as "large research labs and pharmaceutical companies with very high requirements concerning sensitivity, quality of data and productivity". The customers who had installed BIAcore 1000 were negatively defined as those research labs and pharmaceutical companies that did not have the same high requirements. Finally, the customers of BIAcore X (BIALite) were characterised as "shared laboratory environments where the technology is used together with other established laboratory tools such as spectroscope, fluorescent and separation methods".<sup>32</sup>

The way of relating to the post-1995 user was to provide support in terms of how the instrument worked per se, not how it interacted with the user's research questions. Prior to a sale, an Application Specialist would demonstrate the instrument either at Biacore or at the customer's site. This allowed the customer to gain initial hands-on experience. Further, there were a number of self-training products, such as CDs and books, alongside a series of

Biacore-run training courses. On-line support via Biacore's website included web-based tutorials, interactive CDs, Application Notes, the reference database and the BIAjournal. There was also 'general customer support', with advice provided via email or telephone.

The new way of interacting with customers was also reflected in the users' behaviour. Pre-1995 users engaged in developing new applications, and in developing the limits for how to use the instrument. Although their questions may have shifted from "can I use BIAcore to address my research questions" with regard to the first machines, to exploring the limits of the machines or new ways of using them, they continue to develop new applications to the present day. The results of their efforts are usually given to the company, and later distributed to other users via application newsletters. Many of these users consider they have a long-term relationship with Biacore, and describe themselves as belonging to a Biacore user community.

According to Biacore, the early customers and their subsequent publications acted as an indirect but very important user influence "being communicated throughout the user community". This indirect influence is "difficult to map", but involves new users reading publications and "having their thinking developed... rather than endless sampling, we shifted the new users to look at publications...as the body of publications grew, we were able to end such discussions: others have succeeded, why shouldn't you?"<sup>33</sup> Sales figures are not the same as usage rates, however. Nevertheless, the early users have a potential role in indirectly generating follower users, not simply purchasers of the biotech tool.

In summary, although the new way of interacting with customers was more cost-efficient, Biacore incurred costs in terms of a loss of intense application development and perhaps more important, in assisting newer users to embed current applications. As a former technical specialist comments: "Maybe people now are over optimistic in expecting it to work because there are lots of publications. Then they run into problems, especially if they have a "kit mindset", i.e. you push the button and get the numbers out...". In total, about 1500 instruments have been installed since 1990 (2003 data).

#### *Commentary: A market orientation phase*

Clearly, there was an effort once again to group different types of users into categories – customer types or segments. But this time, the situation was different. First of all, there was not only one object that was being discussed. A range of BIAcore machines were now available and there was a pattern emerging as to the character of the customers buying each of them. In addition, related to the fact that the technology was becoming established, there were also a wide variety of auxiliary objects – scientific publications, training-workshops, CDs and web-based materials, etc. Still, despite efforts to improve ease of use, a BIAcore was not (yet?) a "push the button" piece of kit. The ideas of introducing additional versions of the instrument in order to interest a wider group of labs suggest that this was seen as an area with potential. Moreover, there were ideas emerging on new application areas, indicating that completely new market segments might be accessible in the future.

An important change in the interaction with new customers took place during this period, seemingly triggered by the growing financial pressures on Biacore. This in turn seems to be related to the continued development of Biacore as an actor. The gradual shift in the identity of Biacore from being an internal research project into an independent market actor, which started during the previous phase, was further emphasised through the IPO and the listing of Biacore on the stock exchange. This turned Biacore into something of interest to a much wider group of actors than its employees, customers and owner, adding further commercial pressures to the organisation.

The standardization of the interaction with new customers also seems to have relied on the degree to which the BIA technology was established. With a growing body of

publications testifying to the functionality of the technology and possible applications in antibody characterisation and protein interactions, a shift of blame was becoming possible. In the early post-launch years, Biacore had clearly assumed accountability for non-results linking them to the characteristics of the instrument, illustrated for instance by the development of new software. Increasingly, however, Biacore was able to hold users accountable for non-results. By amassing publications, producing manuals, analysis software, instruction CD's etc., Biacore in fact increased the ability of new, first-time users to assume accountability. By investing new users with a history that they did not actually have, their ostensive fit with the envisioned user-instrument interaction grew.

Despite these efforts to standardise interactions with new customers, many long-term relationships with early users remained. Hence, Biacore aggregated users into segments, but continued to have more personal relationships with some users. Perhaps there was a role for experimentation here – a role that Biacore in fact still supports. For a post-1995 new user, however, there was a need to fit into the aggregations undertaken as a result of the interactive activity with early users. The activities with the post-1995 users were more transactional, or more arm's length. The early users played a role in enabling Biacore to shift part of the expense of having an extensive user base.

### 3.0. Analysis

The starting point in this paper was to question whether Biacore was “in the enviable position of creating its own market” (Abelin 1997-02-03). The case above has traced in some detail how Biacore sought to build exchange relationships, user networks and market segments for their affinity biosensor. The focus on network creation is relatively novel in that many of the empirical IMP studies have focused on developing and maintaining (and to a lesser extent dissolving) relationships and networks (see, e.g., Lundgren 1995; Pedersen et al 2005 for exceptions). Perhaps one reason is that it is difficult to argue that ‘creation’ occurs; networks are a product of their history, and it is a question of where boundaries are placed (see Ford and Redwood, 2005, for a timely explication of this point).

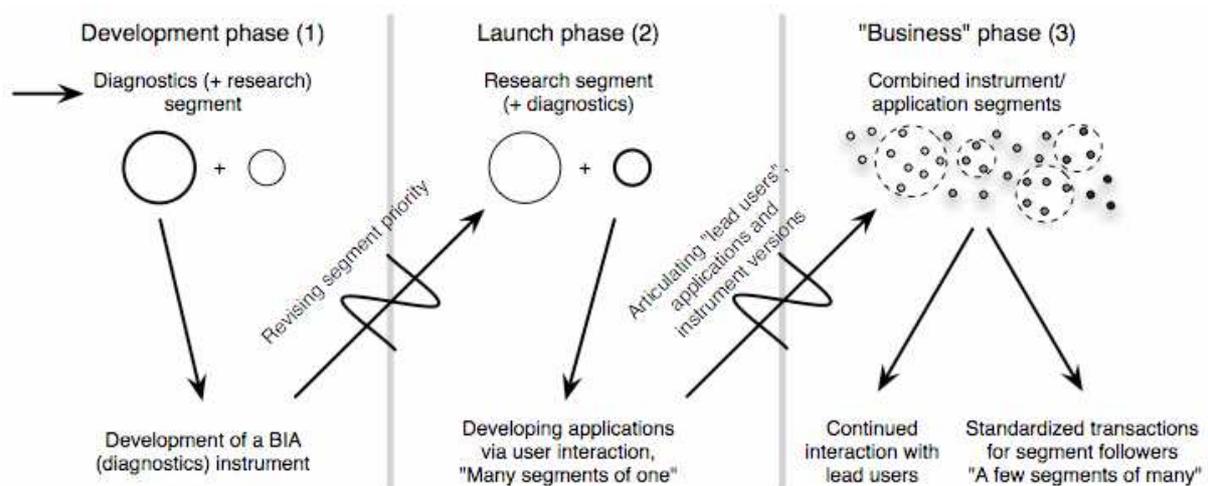
Notwithstanding this analytical argument, we argue that the Biacore case provides an example of the multiple interactions leading to the stabilisation of an organisation, a product object, users and a set of application/technology segments. The interactive creation of exchange relationships and user networks generates an ongoing and moving development of market segments for the affinity biosensor. We would argue that, at least in retrospect, an evolutionary, emergent and interactive (Håkansson and Ford 2002) market strategy (Turnbull and Valla 1986; Valla 1986; Håkansson 1982) might be discussed. For even if resource commitments and activities were “not planned as investments...[they] have long-term consequences and should be regarded as investment processes” (Johanson and Wootz 1986:80). The term network position offers one way of summarizing the results of such investments (Johanson & Mattsson, 1985), either for individual customer relationships (micro position) or for a specific national market (macro position). More recently, Araujo (forthcoming, 2007) has also argued for the link between such investments and market-making processes.

The efforts undertaken by an actor to alter its network position and the characteristics of the surrounding business network – or more generally, to alter an economic order – have been characterized as interplay between *networking* and *sense making* (Johanson & Mattsson, 1992; Ford & Redwood, 2005). Any attempt to influence others will be based on the actor's “view of the complex inter-dependencies that exist in the network” (ibid. p.649). But since networks are boundless in principle, any such view must be arrived at by setting boundaries,

determining what is relevant to take into account and what is not (confer Lundgren 1995). Johanson & Mattsson (1992) suggest that such considerations are significantly shaped by an actor's network theory, i.e. the tools that actors employ to interpret their situation.

To the best of our knowledge, the interplay between micro and macro positions as well as networking and sense making is relatively underdeveloped, in particular in terms of network creation / market making. In the case above, the interactive creation of exchange relationships and user networks via market and marketing investment activities blend with efforts to establish a strategic vision in the process of developing industrial market segments for the affinity biosensor. The movements between on-going interactions involving Biacore staff, key technologies and potential users on the one hand, and efforts to take stock, make sense of the situation and identify a strategic direction, on the other, provides opportunities to develop further our understanding of network dynamics.

One particularly fascinating aspect of the case concerns the tensions and transitions between "segments of many" and "segments of one" that result from Biacore's efforts to segment the BIAcore users in the emerging market for biosensors (see Brennan et al 2007 for an overview of industrial marketing segmentation). There is a long-term, iterative character to the described market-making process, which seems to be significantly affected by the interactions undertaken and choices made by the involved actors. The resulting image is of a market-making process passing through different stages, suggesting that even transaction-based markets may have an interaction-based history (see Figure 2).



**Figure 2. Phases and transitions in the development of the market for BIAcore.**

In the first phase of the case ("Development phase" in Figure 2), there were clear ideas about what the relevant customer relationships and segments were. An initial segmentation was 'imported' or 'borrowed' from Pharmacia Diagnostics. The potential user base was punctualised as two ideal customers, aggregating users into two segments, and one of these – practicing doctors (large circle) – was selected as the most relevant. There are various reasons as to why the practicing doctors were regarded as one actor. There was a standardised pattern of use, which provided the physical object a defined use and a clear set of product characteristics. In addition, Pharmacia Diagnostics had an important role in envisioning the potential market for the tool. The new tool was complementary to an existing product range, and as such could benefit from existing marketing and market investments by using this

incremental approach. This segmentation then informed the initial efforts to develop the instrument.

For the reasons described in the case, a re-evaluation of the initially identified segments took place, marking the transition to the second phase (“Launch phase”). The smaller idealized segment, consisting of researchers in research labs (small circle), was now considered – or at least presented - as “well definable and homogenous”. However, there was no clear relation between these potential users and the new tool. In other words, the success of the project now depended on establishing working relationships with individuals within the targeted segment to develop applications. There were no competitors or market co-creators to assist Biacore here (cf. Johanson and Mattsson, 1985). This resulted in customisation of activities by individual users, which was both very expensive and very necessary. The “well definable and homogenous” segment proved difficult to find, suggesting that there is a difference between talking segmentation and walking segmentation.

Instead, there emerged “segments of one” (e.g. Shapiro and Bonoma, 1984; Freytag and Clarke, 2001) that interacted and experimented with Biacore technical staff. Hence, in establishing relationships with early users, investments in exchange relationships were required. Several users became “key opinion leaders” on how the instrument could be used, influencing Biacore’s (market) reputation. Biacore also sought to systematically collect the experiences gained through user interaction, e.g. through the BIA symposia, BIA journal, and BIA database etc. These sorts of centralising marketing activities on the part of Biacore, for reputation and trust building, made it possible at a later stage to take a more aggregated view of the market. In other words, Biacore was creating internal assets that were used to develop external market assets (cf. Johanson and Mattson) as the project developed over time in interaction with users. This interaction on the one hand firmed up Biacore as an actor with a skeleton of a market position, along with numerous assets regarding the continued internal / market asset investment.

This middle period contained and/or produced substantial heterogeneity. The intensive interactions between Biacore and prospective customers enabled users to define the dimensions upon which Biacore would later standardise around a few ‘ideal customers’, i.e. to create some homogeneous ‘segments of many’ based on particular developed applications. In other words, lead users provided the bases of segmentation rather than the firm. The “segments of one” that emerged as a result of the interaction replaced the previous ideas of a homogeneous segment of customers in a general research application.

The transition to the third phase of the case (“commercial phase” in Figure 2) was triggered by a strong (and understandable) desire to move away from ‘segments of one’. It was expensive to maintain the contact patterns involved in such customisation (the central problem of such segmentation strategies), not least as the volume of users increased. An important change in the interaction with new customers took place, which appears to be related to the continued development of Biacore as an actor. Furthermore, multiple objects – the range of machines – with their associated use patterns were now available.

There was an interplay between networking and sense making as the activities involved in the “explosion of applications” led to a gradual accumulation of an identity for the Biacore as ‘an instrument for’ certain applications. The previous segment of ideal customers now emerged as a collection of individual and unique users, with many user-led punctualisations in operation. Further, Biacore was beginning to acquire an identity within the prospective market, as a result of these activities taking place, alongside the establishment of a separate sales organisation. The object of exchange and the actors of exchange are being created and developed throughout this process.

Based on the experience gained, Biacore identified a number of ‘ideal customers’, which could form the basis for ‘segments of many’. The numerous applications that had been

collected in the database etc, were bundled together. This was a conscious effort to punctualise, largely informed by the new commercial perspective that was being espoused by Biacore. As far as the company's managers were concerned, it was important that this punctualisation was kept intact, due not least to the perceived need to change culture and be viable on the stock market. Those actually muddling through the interactive process might not have been able to formulate such a change in strategy. The market-making process illustrates variation in terms of both who was acting on behalf of Biacore and what view of the market informed their actions. In the latter part of phase 2, the 'segments of one' that emerged as a result of user interactions, significantly affected Biacore's view of the market for biosensors, not least for the technical staff who were directly involved in customer interactions.

To address the identified 'segments of many' a substantial part of the previous interactive contact pattern was packaged into saleable products or auxiliary objects, e.g. CDs etc for a more economic sales support process. Market-based investments in the database etc. were a part of this. In other words, for a post-1995 new user, there was a need to fit into the aggregations undertaken as a result of the interactive activity with early users. The interaction with the newer users was less interactive and more transaction-based. The standardization of the interaction with new customers increased the ability of new, first-time users to assume accountability for their use. By investing new users with a history that they did not actually have, or perhaps by not allowing them to be lead users, not all have been able to achieve their envisioned instrument use.

This shift to attempt a more aggregated segmentation again does not account for all activities occurring in the third phase, as illustrated in Figure 2. The series of technology/application segment aggregations decided upon for post-1995 users sit alongside ongoing relationships with the early users. In other words, there were parallel networking efforts on the part of Biacore, in terms of the efforts to continue relating to the early users in the same way, alongside standardising how the new users were handled. The previous creation of 'segments of many' facilitated this. Biacore was able to continue to learn, to form visions for new application areas (such as food) through continued interaction

Overall we can say that there were attempts to operate in a more market-like way: "markets-from-networks". But these efforts also relied on continued interaction with early users: "markets maintained by networks". In other words, as below in our conclusion, to try and get that enviable position of creating one's own market is actually quite hard work!

#### **4.0. Discussion**

Overall, the case illustrates a process of movement through different stages in the development of a market. It suggests that even transaction-based markets may have an interaction-based history and backdrop (cf. Johanson and Mattson, 1985; Araujo, 2007). The first stage has a very firm-centred perspective on the creation of a network, with clear assumptions made about whom the customers are and their needs. The intermediary stage regards the interactive development of users' needs and product characteristics. This can, at least in hindsight, be viewed as the interactive generation of market segmentation dimensions or criteria. In the third stage, Biacore draws on the experience from user interactions when aggregating segments of users in an attempt to operate in a more market-like way. In other words, this is a "markets from networks" story, whereby a network is built upon, in creating structures that are more market like, at least in part. The latter sections in particular illustrate a perspective taken by the firm of the network of relationships becoming dense enough to form a more macro view.

As regards the initial claim concerning the enviable position of Biacore, the case shows that considerable work is needed to achieve the standardization necessary for market-type transactions to be possible (cf. Araujo 2007; Johanson and Mattsson 1985). Somewhat ironically, the case suggests that “thick”, interactive relations are important for achieving this. That is, standardisation around a triad of market segments, users and the actor itself. Second, the overall story suggests that it is perhaps not that easy to have to carry the investments necessary to create a market on your own, not least when taking for granted users’ use.

The case presented illustrates a multiplicity of versions of markets. The firm’s versions of the market varied by the different ideas of what Biacore encapsulated: some were representations to the stock market, some were representations of a commercial / sales mentality, and still others were very much based upon interactions with individual lead user customers. The multiplicity of markets is partly a more linear process and partly one in parallel. The case illustrates how visions of the market multiply as the account develops. Initially there is a limited version because of the withdrawal of the diagnostics application. Over time, multiplying versions grow out of the interactive development process with multiple users. The more parallel multiplicity of markets occurs in particular in phase three, as Biacore splinter into maintaining intense interactions with the early users alongside a more standardised version of interactions with new users.

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## Endnotes

- <sup>1</sup> BIA is short for Biomolecular Interaction Analysis.
- <sup>2</sup> All of the information provided in describing the features of the Biacore tool is taken from <http://www.Biacore.com/technology>
- <sup>3</sup> Specificity measures how specific is the binding between two molecules, concentration addresses how much of a given molecule is present and active, kinetics deals with the rate of association and disassociation of molecules, and affinity measures the strength of the binding of two molecules (<http://www.Biacore.com>)
- <sup>4</sup> Biacore press releases 2004, "Biacore announces update on 'Strategic Business Review'".
- <sup>5</sup> <http://www.sciencemag.org>
- <sup>6</sup> We would like to thank Alexandra Waluszewski, of Uppsala University, for her input and contribution to the collection and writing of the case study material.
- <sup>7</sup> Interview with the CEO of Pharmacia in January 1987 (from the Swedish business magazine *Veckans Affärer*, 1987, No 3, p. 4).
- <sup>8</sup> *Veckans affärer*, "Pharmacias biosensor når marknaden 1990", 1989-01-09.
- <sup>9</sup> (Andersson, 1996:322)
- <sup>10</sup> In essence this application is concerned with how a molecule binds to a particular antibody. This can be performed with other techniques, e.g. Elizia. This activity took place from 1987 onwards. There was a need to detail convincing examples of repeatable applications, and to get re-agents in order to be able to run demonstrations or workshops at customer / user sites.
- <sup>11</sup> Ibid.
- <sup>12</sup> Eric Walldén, Marketing Director at Pharmacia Biosensor, quoted in *Veckans affärer*, 1991-03-20.
- <sup>13</sup> IPO Prospect, p.18.
- <sup>14</sup> Andersson, 1996:85.
- <sup>15</sup> *ibid.* p.89
- <sup>16</sup> Interview with senior scientist at Astra Zeneca Gothenburg
- <sup>17</sup> E.g. *BIA Journal*, 2:2, 1995, p.15.
- <sup>18</sup> Interview with senior scientist at Leeds University
- <sup>19</sup> *Biosensors – A Rapidly Expanding Sector*, *Kemisk Tidskrift*, Vol. 106, No. 7, 55-56, 16<sup>th</sup> June 1994.
- <sup>20</sup> *Making the most of the opportunities*, *BIA Journal*, vol.1:1, p.10-11.
- <sup>21</sup> *BIA gets set for the next century*, *BIA Journal*, vol 2:1, p.3-4.
- <sup>22</sup> *Biosensors Seek Future Markets*, *Industries in Transition Business Communications Co.*, 22:2, Jun 1994.
- <sup>23</sup> *Moving into new spheres*, *BIA Journal*, vol 2:2, p.10-13.
- <sup>24</sup> Sweden-U.S. Pharmacia & Upjohn/Biacore-4:Snapshot, *Dow Jones International News*, 27 Nov. 1996.
- <sup>25</sup> Biacore SEC Filing for Initial Public Offering, *PR Newswire*, 7 Nov. 1996.
- <sup>26</sup> The new company was to be listed on Nasdaq and on the Stockholm Stock Exchange. The announced public offering was managed by Goldman Sachs & co and Hambrecht & Quist LLC in the US and Enskilda Securities internationally. 5 million shares were offered, of which P&U held 3.5 million, and 1.5 million were new shares. (*Pharmacia to Sell Biacore to Investors*, *The New York Times*, 8 Nov. 1996, page 4; *Inbjudan till förvärv av aktier i Biacore International AB* (Prospect), Pharmacia & Upjohn, 8 Nov. 1996; and *Pharmacia & Upjohn Inc.*, *Analytical Instrument Industry Report*, Vol. 13, 15, 27 Nov. 1996.)
- <sup>27</sup> The initial valuation of the company was SEK 1.04 billion (€ 116 million) (*Biacore lists in Sweden at premium*, *Reuters News*, 3 Dec. 1996.)
- <sup>28</sup> *Pharmacia-Upjohn group sets Biacore share price*, *Agence France-Presse*, 27 Nov. 1996.
- <sup>29</sup> *P&U cuts Biacore stake to 41 pct.*, *Reuters News*, 18 Dec. 1996.
- <sup>30</sup> *Biacore/Pricing-2: Proceeds to Strengthen Distribution*, *Dow Jones News Service*, 27 Nov 1996.
- <sup>31</sup> *Inbjudan till förvärv av aktier i Biacore International AB* (Prospect), Pharmacia & Upjohn, 8 Nov. 1996, p.21.
- <sup>32</sup> *Ibid.*, p.28.
- <sup>33</sup> Biacore have developed and maintain a publications database, and in-house reviewers read everything that is published that involves Biacore. Further, there is a database maintained by the R&D department where protocols are posted. These protocols are both developed in house by R&D and are also sent in by customers who are developing new applications. A newsletter is sent to users six times a year. In the newsletter new applications and experiments are posted as new technology notes or new application notes. In addition, the *Biajournal* goes out several times a year. Each time the journal is focused on life sciences, pharmaceuticals, or food issues (the three main customer areas). "It includes new publications that we really want to promote". Further, the possibility to hear more experienced users at the *Biasymposia* "changed the direction of more beginner users' research".