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RESON
Strategy, R&D and the Management of Technology

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Foreword

This case is the first in a series of company cases on strategy, organization and management of technology headed by Jens Frøslev Christensen at Department of Industrial Economics and Strategy, Copenhagen Business School. The objective of these cases is twofold: to generate empirical inputs from business practice to both ongoing research and case-teaching exercises within the field of Management of Technology.

This case study does not pretend to give a full and final account of Reson A/S. The study provides a broad outline of Reson's historical development, industrial and competitive context, management, strategy and organization, with special attention to R&D and management of technology.

The case builds on interviews with managers at Reson (a chronological list of interviews and interviewees can be found in appendix 1), internal reports and company material. We would like to extend our warmest thanks to R&D manager Steen Bruun and managing director Claus Steenstrup who have made decisive contributions to this case.

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Copenhagen, October 1999

1. Introduction

During their studies, the three brothers Claus, Jens and Per Steenstrup decided that they wanted to go into business together. Although they lacked a clear business vision, they had a vague conception that the potential complementarities of their respective professional skills could become a viable basis on which to start a commercial venture. Claus studied business economics at Copenhagen Business School, Per and Jens both were engineering students at the Technical University of Denmark, Per specialized in electronics engineering, Jens in mechanical engineering. In 1976 they founded the firm Reson.

Along with his study at the Technical University of Denmark, Per had a part-time student job for professor Bjørnø, an internationally renowned scientist within the field of ultrasonics. Inspired by professor Bjørnø, Per decided to focus his masters thesis on ultrasonic homogenizers. This was the first step in shaping the new company's business mission.

Since its establishment, Reson has developed into a leading international company in high power ultrasonics, underwater acoustics, and transducer and sensor technology. Reson's articulated business concept in the late 1990s is to develop, produce and sell highly innovative and state-of-the-art products that reflect actual market needs and are based upon complementary and supporting technologies in the fields of signal transmission, acquisition and processing. Today, Reson markets its products worldwide for a wide range of purposes within three broad product niches:

High power ultrasonics for the improvement of cost efficiency, performance and competitiveness of many industrial products and processes associated with homogenization, cleaning and washing processes. Today, the turnover from these products is third in the contribution to Reson's overall turnover.

Transducers and hydrophones for a wide range of applications such as navigation, communication, distance and velocity measurements, calibration and reference measurements. This area is the second most important in contributions to Reson's turnover.

Sonar systems for mine counter measures, planning of oil and gas production facilities offshore, inspection of man-made structures on the seafloor and seafloor mapping. Sonar systems are the most important in respect of contributions to Reson's turnover.

The customer base comprises a rich variety of customer types, e.g. offshore operators such as dredging and survey companies, laboratories, the defense sector, power and heating plants, and manufacturing companies, including manufacturers of echo sounder systems and flow meter systems, machine and electroplating processing companies.

In order to remain at the technological edge, the company employs more than 30% of its total staff in R&D. They carry out projects covering diverse technologies, such as acoustics, finite element transducer modeling, data acquisition and data processing, software and electronics.

Figure 1 provides a chronological overview of the most important milestones in Reson's history:

1976	*Reson was founded*
1977	*Oil crisis. Development and introduction of ultrasonic homogenizer for power supply plants*
1978	*Development and introduction of ultrasonic homogenizer for ship engines. License agreement with a Swedish company.*
1982	*Request from echo sounder producer. Development and production of transducers for echo sounders*
1983	*Development of hydrophones for navy use*
1984	*Established subsidiary company in Santa Barbara*
1985	*Sonar system for submarines*
1990	*Supply of Venture capital*
1991	*Multibeam sonar system for the offshore industry*
1996	*Digital multibeam sonar system*

Figure 1: Milestones in Reson's history

In 1998 Reson had 85 employees, of which 35 are employed in Santa Barbara in the U.S., another 3 in Aberdeen, and the rest (47) in the company's main office in Slangerup, Denmark. In 1997, the profit in the RESON group reached 5 mill DKK.

(in 1.000 DKK)	1979	1982	1985	1988	1991	1994	1995	1997	1998
Employees*)	5	6	13	21	45	56	61	54	85
Gross Profit	622	1.842	6.489	9.936	17.163	19.251	21.716	29.311	n/a
Profit	-161	549	36	1.078	1.667	-886	2.022	5.116	n/a

Table 1: Number of employees and annual profit in Reson 1979-1998. *) The number of employees includes full time employed only.

Except for the founding years, Reson has only recorded a loss in 1994. This dive in 1994, particularly in gross profit but also in profit, was due to a significant decline within the military market for transducers and hydrophones - one of Reson's major markets - combined with massive investments in penetrating new markets. The numbers from 1995 indicates that these investments have proven successful in returning to profitability and high growth.

2. Reson's product market and technology paths

During the first years of the company's existence, Reson undertook a range of different project activities related to ultrasonic transducer technology. Professor Bjørnø was instrumental in bringing about contacts for the projects. The first project was initiated in 1976, after a request from the National Museum of Denmark, which wanted to find out whether the ultrasonic transducer technology could be used for the cleaning and maintenance of archaeological/historical fabrics. Well-functioning solutions were developed and this equipment is still in use. However, further commercial activities were not pursued within this specialized field.

The following year - during the international oil crisis - a new market opportunity for Reson's ultrasonic transducer skills emerged. Oil refineries had begun to extract a higher percentage of the crude oil for high-end purposes such as jet fuel and petrol for cars. As a consequence of these more efficient refining processes, the quality of the residual oil products used as fuel for ship engines and

stationary power supply units was deteriorating, thus giving rise to decreasing economic efficiency in use and increasing environmental problems. However, it was known that these problems could be solved or reduced if the heavy fuel could be homogenized with water. The Reson-brothers grasped the opportunity to mobilize their ultrasonic transducer skills for this development purpose.

Initially, the ultrasonic homogenizer was developed for power supply and district heating plants only[1]. However, after a request from B&W Engine (a major Danish ship engine manufacturer later acquired by the German MAN group), the equipment was soon (1978) adapted to maritime use as well[2]. This request was also first directed at Professor Bjørnø, who passed it on to Reson. In 1980 Reson was granted a patent on the concept behind the homogenizer in several industrial countries. This patent was later extended to a de facto world patent.

During the next few years, Reson successfully exploited the market options for homogenizers on land - especially among district heating plants and manufacturing companies - initially in Denmark and subsequently in foreign markets such as Norway, Sweden, Germany and Japan. Moreover, Reson considered ways to gain access to the maritime market. That, however, proved extremely difficult. While the homogenizer for on-shore use contributed to improve the efficiency and environmental quality of existing systems, for maritime use the homogenizer was considered a rival to existing technical solutions (separators). Furthermore, restrictive and costly authorization procedures provided significant entry barriers for Reson. A world-leading Swedish manufacturer of separators for maritime use showed interest in the homogenizer, and in 1983 Reson entered a license contract with this company[3]. According to this contract, the Swedish company acquired the right to exploit (produce, sell, and further develop) the homogenizer exclusively for the maritime market. The following years Reson received a substantial cash-inflow from

[1] The circumstances under which this development work took place is described in Christensen, Jens Frøslev (1995): *Produktinnovation – proces og strategi*, Handelshøjskolens Forlag.

[2] By developing the equipment for homogenizing water in ship fuel Reson also provided a new solution to another problem for ship engines - namely that ship engines are in general not very resistant to water. Until then ships had been equipped with separators to separate water from the ship fuel. Now it was possible both to homogenize water into fuel and - on top of that - increase operational efficiency and reduce environmental problems.

[3] See Christensen (1995) (note 1).

the licensee. This lasted until 1991, when the Swedish company terminated the agreement, and the rights to the maritime market returned to Reson[4].

In the beginning of the 1980s, the Danish demand for ultrasonic homogenizers for on-shore use began to decline, due primarily to a decision made by the Danish Parliament to subsidize the exploitation of the relatively rich Danish resources of natural gas with the aim of substituting fuel combustion with natural gas combustion in power supply and district heating as well as in manufacturing plants. By that time 60% of Reson's total sales was based on homogenizers for Danish district heating plants. Since both the German and Norwegian markets were likely to move in the same direction, Reson decided to downsize its significant R&D efforts within this area. It was also decided to attempt to standardize the product for sales in larger series and for a broader market segment.

However, in 1982, while facing these depressing prospects for the homogenizer market, Reson received a request from a Danish producer of echo sounders that - in hindsight - would create the most decisive strategic opportunity in Reson's history (together with the early request to develop the homogenizer). The echo sounder firm was discontented with its existing supplier of transducers for echo sounders and was therefore searching for a supplier that could produce a better quality of transducers at lower price. Reson managed to meet the criteria and got the contract.

[4] In fact the licensee had not used the property rights of the homogenizer for the maritime market to effectively exploit this market. Rather it seems that the Swedish company used the license contract to protect the separator market.

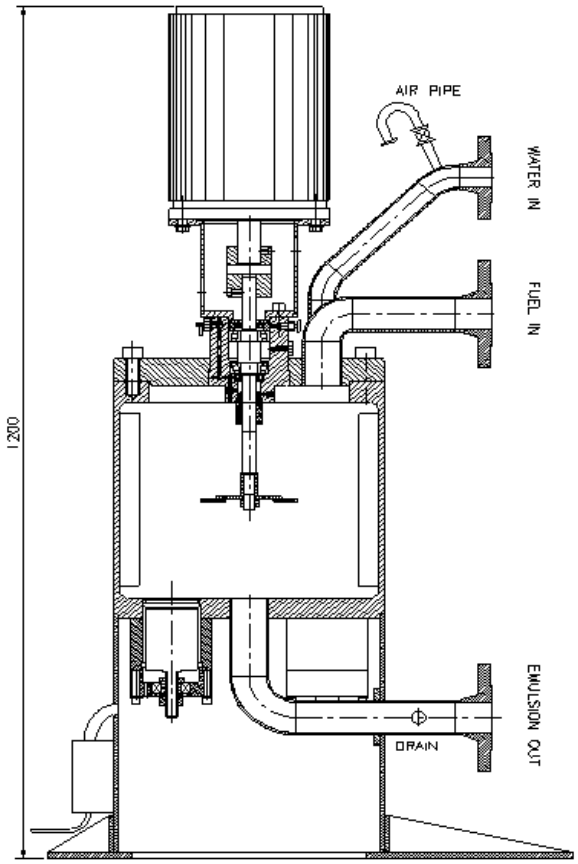

Figure 2: A schematic profile of the ultrasonic homogenizer

Note: The basic principle of an ultrasonic homogenizer is that a high power ultrasonic transducer can initiate local boiling in a fluid, and the boiling effect can be exploited to homogenize fluids (even when they are not mixable by nature), or for cleaning and washing processes, etc.

This was the beginning of a very promising new path for Reson. In order to develop and produce transducers for echo sounders, Reson was forced to develop a certain level of capability in underwater acoustics, and this eventually paved the way for a request from the Danish navy concerning the delivery of ultrasonic transducers for sub-sea use (hydrophones) by submarines. Thus, by combining its existing ultrasonic transducer capability with the newly acquired capability in underwater acoustics, Reson was able to develop and deliver hydrophones for both the Danish and Norwegian navy only one year after it had entered the business of signal-based transducers. The earnings from these contracts provided an economic platform for expanding development activities within this new field.

In the years to come, Reson concentrated more and more on securing and expanding its position as supplier of echo sounder transducers and hydrophones to original equipment manufacturers (OEMs). The military market became the main source of income for Reson in the rest of the 1980s. The defense sector constituted the prime mover in pushing the technological development of signal equipment, by combining advanced user-needs with a willingness to finance the costs associated with developing appropriate technologies. However, in the wake of the collapse of the Iron Curtain and the Cold War confrontations in Europe, the defense sector experienced drastic cuts. Since then, the military market has not played the same role for Reson as a generator of development projects - despite its continued market potential for Reson. In the early 1990s Reson several times faced a situation where military customers canceled contracts or did not proceed with existing contracts as expected. After the downsizing of the defense sector, the offshore industry gradually took over as the main driver for development within the area of advanced signal equipment for underwater uses. Increasingly, equipment for military purposes is based on technical solutions developed for the civilian market - and especially the offshore market.

By the mid 1980s, Reson had become strongly dependent on the OEM-market for echo sounder transducers and hydrophones. This development reduced the direct contact to users which had previously been decisive in Reson’s innovative development. It was therefore decided to focus selectively on more complex development tasks in order to become a global front-runner within the area of ultrasonic transducer technology for underwater use. This strategic intent materialized in the development of sonar systems. A sonar is a device through which ultrasonic sound waves can identify the direction towards, and the distance to, an underwater target. A sonar system consists of a transducer, an acoustic sensor (hydrophone) and an echo sounder. Reson originally developed its first sonar system in the context of an order from the Danish navy.

Soon after this order a mutual Danish-German defense project (G2) - including a compensation agreement concerning mine systems - became very decisive for Reson. Reson was selected as a supplier of a large number of standardized components for mine systems. This project was initiated just before the collapse of the Iron Curtain and assured Reson a 5-6 years period with stable turnover and profit and hence, the possibility of long-term planning. Furthermore, the

G2 project initiated learning processes that provided Reson with valuable insights in certification and product documentation processes.

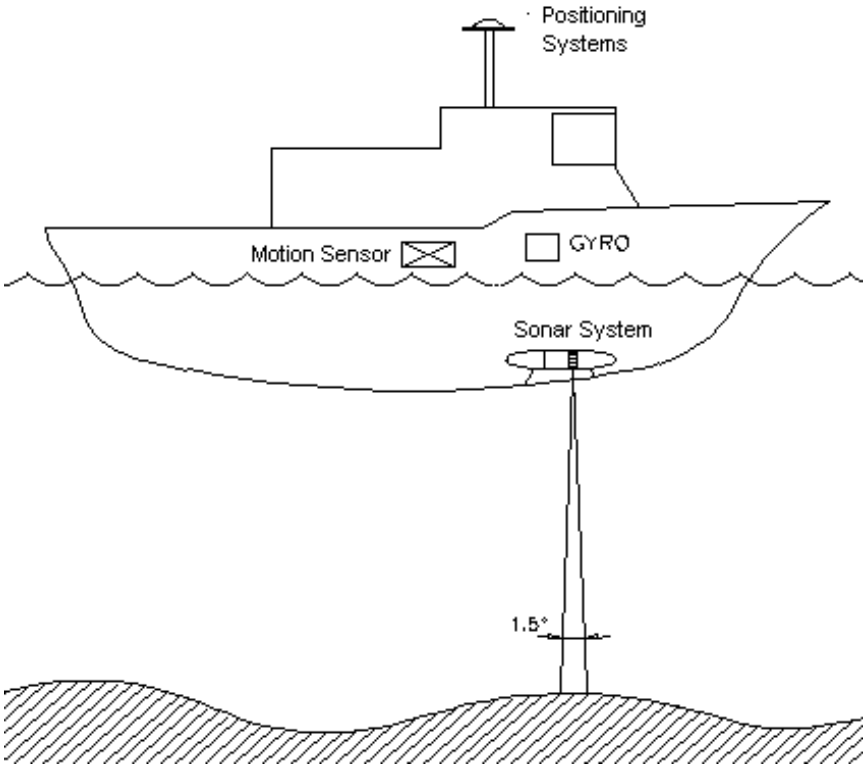

Figure 3: Sonar system

As a result of a high level of customer satisfaction Reson gradually became established in the market as a recognized and responsible supplier of sonar systems for military purposes.

Reson further tried to exploit the knowledge it had gained from producing sonar systems for naval purposes in the development of an optical system for use in the open sea breeding of fishes. With financial support from public sources, Reson in 1990 succeeded in developing a system which could sort fish according to their size. Subsequently, the company had to spend many resources and considerable time on debugging it for actual use situations - e.g. the very rough conditions offered by the sea around the Faeroe Islands. In 1996, it was decided to sell off the optical system, because the activity was considered too distant from the activities of the rest of the company. The property rights to the system were sold to a private consultant within the fishing industry.

In 1991, Reson developed a so-called multi-beam sonar system which,

contrary to earlier systems, was able to produce three-dimensional pictures in one continuous process. This innovation expanded Reson's market platform for undersea navigation, hydrographic surveying of the sea floor, including harbours, and for pipeline construction and maintenance within the offshore industry. Five years later, Reson introduced the second generation of its multibeam sonar systems. The main technological difference between the two generations is that the latter is based on digital technology while the former is based on analog technology. The shift in technology meant that Reson could offer its customers a huge leap forward in the precision and range of coverage of the sonar systems. For Reson, this shift has meant that further development is based on a future-oriented technology. In addition, Reson has created a basic architecure which makes it much easier and cheaper to develop new variants of the sonar system, both for dedicated purposes and custom-made systems. Reson was the first company in its industry to be able to deliver sonar systems based on digital platforms and - as a consequence - faced a very large demand for these systems after they were launched in 1996.

With respect to Reson's original product markets associated with the homogenizer, some development activity has continued throughout the 1980s and 90s. After the Swedish company returned the license for the maritime market, Reson introduced a new generation of homogenizers for maritime diesel engines. However, the changes were only incremental and did not bear any noticeable influence on the sale of homogenizers. Moreover, new applications for high power ultrasonic generator and transducer technology have been explored, especially for washing and cleaning processes. In 1997 new environmental regulation has provided a promising background on which to re-launch the equipment for homogenizing fuel with water and thereby obtain a cleaner combustion. Even though the core technology/fundamental principles of the homogenizer have not changed during the period between the two generations, the re-launch of the homogenizer for ships and stationary power supply units (Reson's very first product) has required a major technological upgrading (cf. section 3.1).

Figure 4 provides an overall illustration of the major diversification and product development events within Reson.

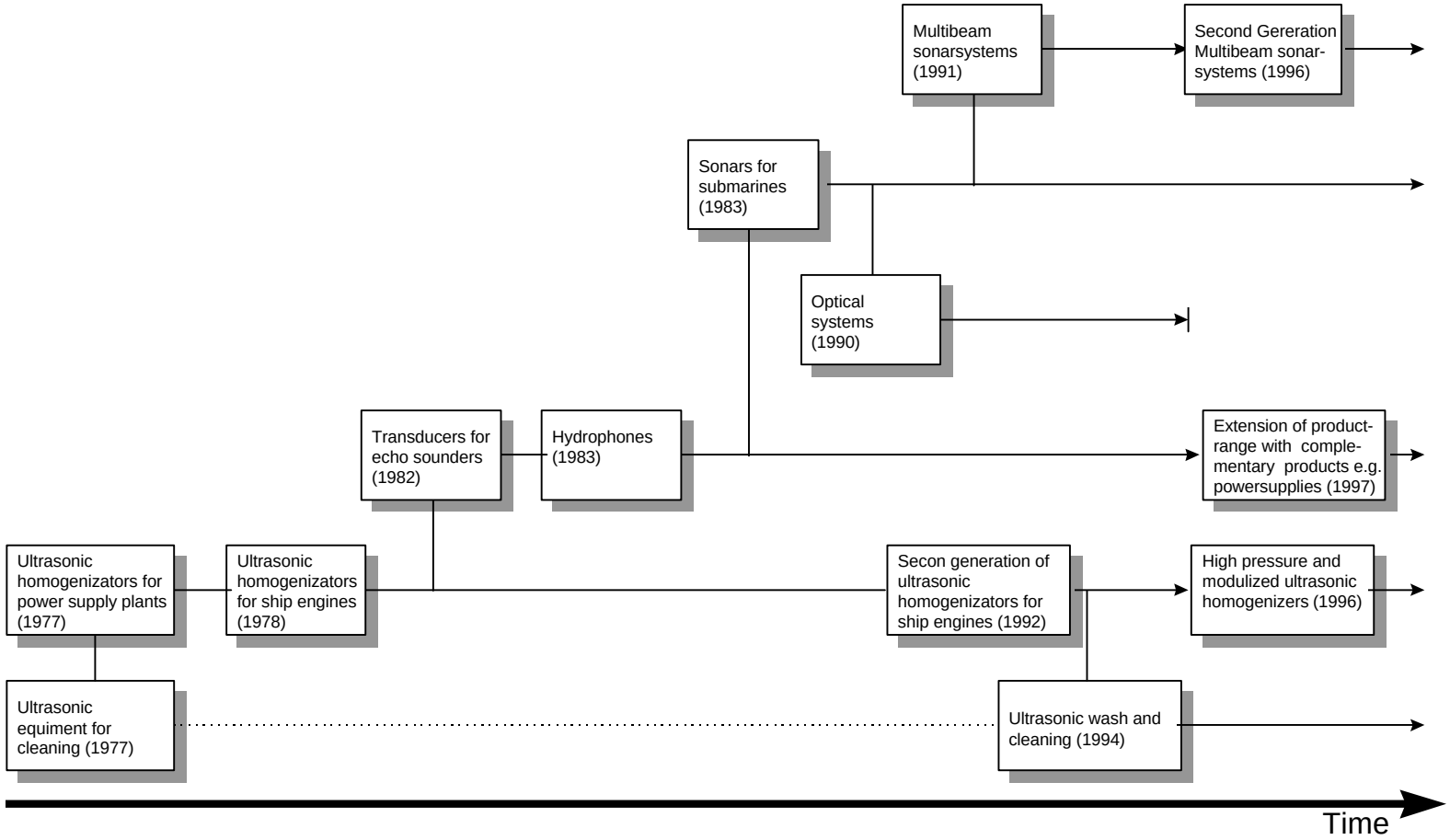

Figure 4: Major product development events in Reson

3. Reson's industrial and competitive context

In this section, the industrial and competitive context of the three product market areas in which Reson operates will be investigated in some depth. The areas are discussed in chronological order, i.e. according to their historical development in Reson: high power ultrasonics, transducers and hydrophones, and sonar systems. As mentioned earlier, the order of economic significance of these areas for Reson is the reverse: the sonar system area is by far the most important, while high power ultrasonics today plays a minor role. This reflects the successful diversification strategies which Reson undertook during the 1980s and 1990s.

3.1 High power Ultrasonics

Homogenizers: The introduction in 1997 of global environmental regulation concerning emission of NO_x made it attractive for Reson to re-launch the equipment for homogenizing fuel with water. Even though the core technology of the homogenizer for ships and stationary power supply units has not changed fundamentally two important changes in the utility context have required a substantial technological upgrading:

a) both ships and stationary power supply plants now use a heavier fuel than previously, and
b) while the previous version had limited capacity, and thus only could be used by smaller plants, the challenge was that much larger plants should be able to benefit from homogenizing water into fuel.

Reson responded to these changes in user needs by developing a homogenizer that: i) operates at a much higher temperature and pressure than earlier models, implying that the homogenizers will be able to process heavier oil than earlier, and ii) operates in a modularized system, where a number of homogenizers can be connected in parallel and thereby meet different performance criteria in terms of process capacity. The new generation of homogenizers was also updated with a new IT interface to accommodate the increased need for computerized control and coordination of the equipment.

The new version was initiated by and developed in close cooperation with the world's dominant manufacturer of diesel-powered marine and power supply engines, MAN B&W[5]. Reson has entered an agreement according to which MAN B&W sells engines in which Reson homogenizers form an integral part (as an OEM-component). This agreement, however, does not prevent Reson from selling homogenizers for maritime use on its own, as long as royalty is paid when the homogenizers are installed in MAN B&W systems.

New and more restrictive emission requirements for maritime engines have been approved by the International Maritime Organization (IMO), and when these requirements begin to be enforced by local authorities around year 2000, new ships will have to comply to the stricter rules (and older ships have to comply if they undergo major rebuilding). Thus, a substantial increase in the demand for this type of homogenizer can be expected. Since Man B&W is by far the most dominant manufacturer of ship engines on the world market, Reson expects to profit from its cooperation with MAN B&W. The agreement provides Reson with the competitive advantage that its homogenizers are certificated to be installed on all major MAN B&W ship engines.

The first generation of homogenizer is still protected by a de facto world patent. Reson's patent policy has since changed (see section 6.5 on changes in Reson's patent policy), but Reson expects to be able to secure protection through constant technological improvements and reputation. Reson still has no competitors that produce ultrasonic homogenizers. However, several competitors operate within conventional high-pressure homogenizing, which is a mechanical process. Within the application areas of Reson's homogenizer, high-pressure equipment is more energy-consuming and is exposed to harder mechanical wear than the ultrasonic homogenizer. However, with respect to finer products such as milk, high-pressure homogenizing is superior in performance and productivity to ultrasonic homogenizing.

Transducers for cleaning: As a consequence of the banning of some chemical cleaners in manufacturing (e.g. freon) and the tightening up of environmental

[5] MAN B&W had won a contract with the government in Malaysia to deliver diesel engines for a mid-size power supply plant at Guam. In order to meet the strict local emission criteria, MAN B&W had to improve its equipment in several dimensions. Reson responded quickly and developed a homogenizer that was specifically customized for the Man B&W system, and that provided a substantial contribution to meeting the emission requirements.

restrictions on others (e.g. the use of organic detergents) implying increasing costs associated with their use, the demand for transducers for cleaning purposes has increased, for example with respect to cleaning machine parts. Within this business of industrial cleaning there are many competitors, and Reson is a minor player mainly selling transducers for ultrasonic cleaning on the European market. More than 80% of Reson's turnover within this market stems from OEM-sales. For Reson, this business area is considered a low-priority spin-off activity in the sense that Reson possesses the relevant technology, but does not – at the moment - consider the market strategically very important.

Transducers for washing: In the beginning of the 1990s Reson used its knowledge base within transducer technology to develop an ultrasonic process for washing machines for the consumer market. The project was funded by the Danish Ministry of Environment and Energy and the ministry which considerable expectations regarding the commercial prospects of the project. Compared to conventional washing, the ultrasonic washing process demonstrated superior qualities in terms of washing time (reduced by about one third on the central washing process), electricity consumption (50% lower), and to some extent cleaning capacity. Thus, Reson has developed a process that worked in practice. However to bring this technology to the market a huge R&D effort still remains, and this can only be carried out by one of the existing washing machine manufacturers. In order to commercialize this invention, Reson is dependent on further moves from washing machine manufacturers. However, so far no manufacturers have shown serious interest in exploiting this new technology in their washing machines. According to Reson this is due to two main reasons: first, the ultrasonic components are still too expensive to produce compared to conventional components, and the production cost will have to be reduced with a factor three before they will be competitive with the present washing machine technology. Reson is not a scale-intensive engineering firm with the ability to pursue an engineering learning curve to decrease cost of production. Secondly, within the established washing machine industry the competitive pressure is intense with a strong focus on incremental reductions in water and electricity consumption. Until now the existing technological paradigm has been able to provide scope for these improvements, and the washing machine industry has therefore only little incentive to introduce any radical change in washing technology and carry the associated costs in terms of both direct R&D activities and change in manufacturing facilities.

3.2 Transducers and hydrophones

The market for transducers is enormous but not very transparent and therefore impossible to quantify. The reason for this is that transducers are used in very discrete ways in many different products across industries, and many industrial companies maintain in-house production of transducers for their own use. Despite an increasing tendency among OEM-producers to outsource transducers and hydrophones, still many OEM-producers retain an in-house capacity. Hence, it is difficult to tell how many firms actually produce transducers and hydrophones. While many firms make transducers for underwater use, only few companies – like Reson – operate on the open market.

Two American firms are Reson's main international competitors. They are dedicated transducer and hydrophone producers with an even more narrow market scope than Reson's. Thus for example, they are not operating within the sonar field. On the other hand, they are larger than Reson and within some areas possess comparative scale advantages. In Denmark, besides Reson one other company also delivers transducers and hydrophones. However, this company has stopped developing its equipment, and is therefore lagging behind technologically.

The main parameters of competition within this product market are price, quality, regional distance and support for integrating the transducers and hydrophones into the end product/system with specific features[6]. The price competition is particularly tough within the sub-market of larger projects (e.g. systems put out to tender by shipyards for measuring the noise profile from ships, requiring hundreds of hydrophones).

Reson has recently extended its product range to include amplifiers and power supplier units[7]. A high degree of complementarity between power supplier units, amplifiers and transducers/hydrophones means that a broader product range bears a positive effect on the turnover of hydrophones and transducers. Besides the benefits

[6] Accurate calibration is crucial to establish exact sensor or system performance according to design specifications and requirements.

[7] The power supplier unit and the amplifier are both specifically designed to work together with Reson's transducers and hydrophones. This has assured Reson's power supply units and amplifiers a competitive lead in comparison with other multi-purpose solutions on the market.

of an increased turnover, Reson makes an additional profit from both the power supply unit and the amplifier.

3.3 Sonar systems

Right now the window of opportunity (defined in this context as the period during which it is possible to market a given product) within the sonar business is less than 2 years. Thus, it is crucial for Reson to develop new products as fast as possible and to meet internal as well as external deadlines. In other words, rigorous time-management is pursued within this business area.

The sonar business comprises a large number of very small companies and a few somewhat larger companies, among which Reson, two German companies, a Norwegian company, and a French company constitute the main players. Each of the companies has a specific profile and business orientation. One of the two German companies for example, is oriented towards sea floor surveying and has a strong position within the military market, while the other German company – like Reson – is more oriented towards the civilian market. The French company is a major competitor within the military market, and much larger than Reson. While these companies are competitors, Reson is also cooperating with some of the companies within specific areas (e.g. within the G2 project Reson was making sensors for one of the two German companies). The Norwegian company, which is significantly larger than Reson, is the competitor that Reson encounters within nearly all of Reson's market areas.

The business is characterized not only by intensive price competition but also by a competitive race to come up with the most accurately operating system. It varies as to which of the firms is in the lead, but generally the competitors are very close to each other. It is possible to gain short term benefits from a technologically superior product, as Reson did in 1996 when pioneering a sonar system based on digital technology[8]. But lead time tends to be very short.

[8] When Reson launched its digital sonar, several competitors were already involved in similar projects, and Reson's lead time lasted about a year.

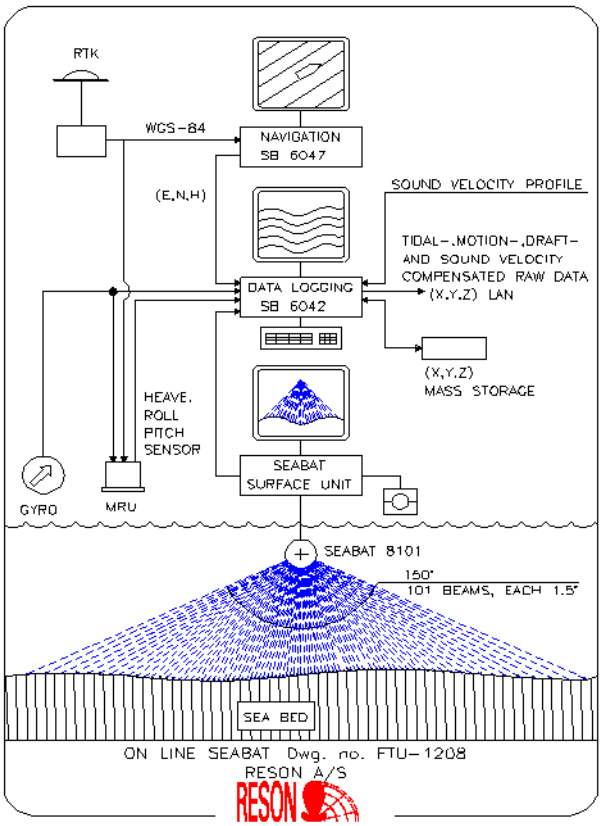

Figure 5: The basic principles of sonar systems

The competing sonar systems differ with respect to the degree to which software is integrated. Reson's sonar system includes software for gathering data, but not software for signal interpretation, for which Reson relies on specialized software houses. Reson's sonar system has an open-ended data interface, which means that it is quite easy for software developing firms to design and develop interfaces between their software solutions and Reson's sonar system. The open-ended nature of the sonar system reflects a strategic decision that Reson does not want to be too closely associated with only one or very few firms. Therefore, Reson has no exclusive agreement with any software developer[9]. Some of the competitors develop the software for processing the data themselves, and therefore have the advantage compared to Reson that they can offer customers an integrated solution.

[9] The buying decision with respect to sonar systems is either taken by a software company or the end user. Consequently, Reson has to market its product towards both segments.

Reson markets its sonar system to three broad application areas: hydrographic surveying, off-shore, and military applications.

Hydrographic surveying: This area involves mapping the sea floor, channels, rivers (e.g. the line of depths), and - among other things - mapping the entrance approach and breakwaters associated with the construction of harbours. Most of the projects within this area undergo a tender process, and it is very important to be in contact with the customers (e.g. contractors and developers) before they announce the invitation for tender, since the initial formulations of e.g. the technological criteria in the invitation, can provide advantages to certain suppliers at the cost of others. At present, Reson has approximately 50% of the global market for sonar systems for hydrographic surveying.

Offshore: This area involves the same functions as mentioned under hydrographic surveying, except that they are dedicated to the offshore market (e.g. mapping of pipelines and cables before, during and after offshore construction). There is a distinction between users within this market, which are mostly contractors, and customers or decision makers which are the concessionaires (e.g. the big oil companies). Within this market area the marketing ”preparation” is especially targeted at the latter group.

In 1991 Reson “sneaked” into this application area and captured a large market share from the exiting suppliers of sonar systems. Until then the market was dominated by the Norwegian company. Reson - as a newcomer - broke this market dominance by introducing a new system which was technologically superior to both the Norwegian company’s and other suppliers’ systems.

Today the competition within this market is very tough, with intensive rivalry over every single contract.

Military: This area involves equipment for navigation and mine/ship detection on board of both submarines and surface vessels. Even though the demand for sonar systems for naval purposes dropped after the termination of the Cold War, the national navies are still a substantial source of demand for sonar systems, although at a lower lever than before. However the demand is very unpredictable, and therefore also difficult to rely on.

Unlike during the Cold War, today there is a tendency in most national navies towards purchasing COTS-products (Custom Off The Shelf). As a consequence, it is very important for the companies in the sonar system business to have a good foothold within the civilian sector in order to be able to distribute the cost of development on more segments. Previously almost all the cost of developing new sonar systems was carried by the national naval institutions, implying that companies who won the contracts with the navies also gained a significant competitive advantage in the civilian sector.

Today, the situation is much more balanced and with a big potential for cross-fertilization between solutions for the military and the civilian sector.

4. Management, strategy and organization

In its early years, Reson was strongly technology-driven. The development was determined by the firm's initial capabilities in ultrasonic and transducer technology. Individually and combined, these technologies formed distinct capabilities on which Reson creatively shaped new - or made inroads into existing and highly different - product fields and market segments. Today, Reson considers itself to be primarily market-driven in its choice of development activities (see section 6.1).

While Reson in the early years was predominantly a project organization in which ongoing development projects dominated, it has gradually assimilated more "functional", "formal" and "operational" features into the organization, while still maintaining the innovative, informal project organization with respect to R&D. This development is due not only to the increasing size of Reson and the regional division into two substantial units (in Slangerup and Santa Barbara), but also to the increasing role that standardized products (in contrast to highly customized products) have come to play for the economic performance of Reson.

4.1 Organization and leadership at group level

During the formative, entrepreneurial years of the firm, the individual skills of the Steenstrup brothers complemented each other very well. Claus took care of sales

and administration, Jens and Per headed the technical development activities associated with electronic engineering (Per) and mechanical engineering (Jens). Due to this complementarity the brothers were - more or less - able to cover all the critical functions in the firm.

In the mid 1980s, Reson established a company office in Santa Barbara in the U.S. Jens pioneered this build-up. The objective was to gain access to development contracts from the U.S. Navy and other U.S. military authorities [10]. In this respect the venture has proven successful. Reson has won several development contracts and has especially gained a significant turnover form sale of sonar systems to U.S. Corps Engineers. Two other benefits from the U.S. unit have been the easier access to highly qualified/specialized engineers in the Silicon Valley area, and easier access to new critical electronic components (see further section 6.1).

When Reson later entered the offshore market, a small branch office was set up in 1992 in Aberdeen, Scotland – the most important global center for the offshore business - in order to get closer to the offshore customers. The offshore market is highly conservative, and the only way to introduce expensive new equipment with which customers are not familiar is to lease or hire out the equipment (such as sonar systems) for a limited period, rather than to try to sell it. Thus, the unit in Aberdeen was established as a lease-pool venture in order to make the Reson equipment known to the market. In 1996, Reson considered that its position was well-established and the lease-pool was sold off. Today, the branch office in Aberdeen only sells, installs and services sonar systems.

[10] USA has very restrictive legislation concerning the relative share of vital products/parts for defense purposes that must be produced within the U.S.

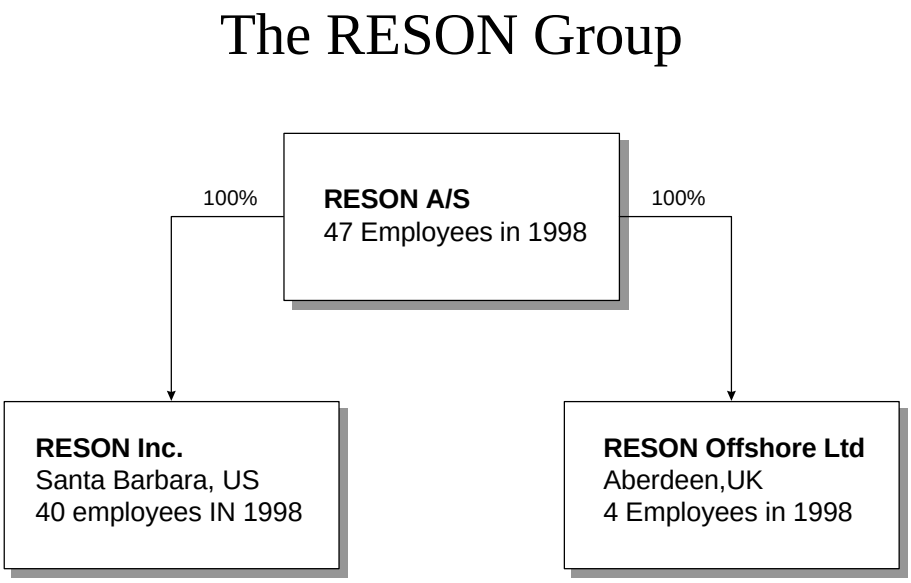

Figure 6: The Reson Group 1998

The administrative complexity associated with the increasingly diversified business activities and distributed technological capabilities, forced Reson to consider the possibilities of a more formal and simple organizational structure. As a consequence, by the late 1980s the Reson group was divided into an ultrasonic and a sonar division. The sonar division was mainly located in and managed from the Santa Barbara office, while the ultrasonic activities were concentrated at Reson's facilities in Denmark.

However, this attempt to formalize a simple divisionalized structure did not prove successful and, in fact, was never fully implemented. The complex network relations between the Santa Barbara office and the Danish section and between development activities linked to different product markets proved impossible to fit into a dual structure and division of labour. Thus, the divisional structure gave way to a structure consisting of two equal units each with a full product range respectively in the U.S. and Europe, and with a certain degree of coordination between the two. Sonar projects are headed by Jens Steenstrup in Santa Barbara and receive inputs from both units (generally, Slangerup accounts for the mechanical acoustic elements, while Santa Barbara accounts for the signal processing elements).

Within the homogenizer and transducer area, the Slangerup unit plays the dominant role in development projects.

While marketing and sales functions were previously shared, each unit has now built up separate marketing and sales functions[11]. Most of the standard items are still produced in Denmark, and the Santa Barbara office is predominantly a project organization even if there is a clear movement towards producing more and more standard products.

Today, the office in Santa Barbara is headed by Jens Steenstrup, while Claus Steenstrup is managing director in Reson A/S.

4.2 Organizational structure

The chart in Figure 7 illustrates how the Danish office is formally organized. The structure of the Santa Barbara unit is very similar.

[11] According to Reson there is a remarkable difference in how marketing and sales within all business areas should be carried out in USA and Europe, for example with respect to how the Internet is approached. Whereas Americans tend to be ready to use the Internet for transactions this is not the case in Europe, where a remarkably widespread resistance against electronic commerce exists in most countries. As a consequence Reson expects to develop and apply different Internet strategies on the two continents.

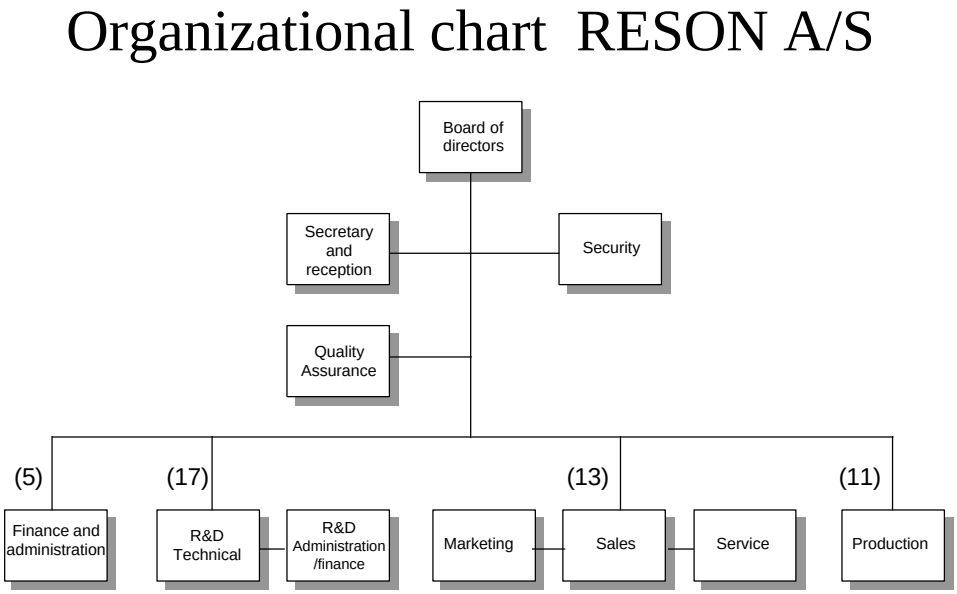

Figure 7: The formal organization of Reson, Denmark, 1998

Note: The number of employees of each department is stated in brackets.

Even though Reson has a traditional functional structure, the organization still exhibits some of the characteristics of a smaller, innovative start-up enterprise. Most coordination between functions takes place on a personal and rather informal, level with a very low degree of management involvement. In section 5, we elaborate on each of the major functions.

4.3 Strategy

Reson has an ambitious growth strategy with an annual growth target of 25% in turnover and profit. During recent years, this target has been met. Reson expects the sonar system area to continue to be the high-growth area for the coming years. However, there may be promising opportunities for a major renaissance within the homogenizer field. Generally Reson expects all the business areas to carry their relative load of the growth, and resources will be allocated accordingly.

Taking into account the diversity of the product portfolio, Reson will continue to pursue an outsourcing strategy with respect to production and system components that are peripheral to Reson's core competencies (section 6.4).

Reson has recently introduced an ongoing strategic process with a strong focus on implementation. This reflects a shift away from former annual strategic events that tended to develop into almost ritual exercises. The ongoing strategic process implies a deeper interest in continuous evaluation and adjustment of action plans for fulfillment of the overall goals and strategies. The process is based on a circular approach starting with a SWOT analysis based on inputs from all functions, followed by the formulation of overall strategies and operational objectives for each of the business areas. When prospects and problems involved in reaching these objectives have been identified or reconsidered within each function, the suggested actions and allocation of resources are the subject of consideration and decision among senior management. This process involves several follow-up meetings during the year.

5. The organization of business functions

This section briefly outlines the following important business functions in Reson: marketing and sales, production management and finance. In section 6 the organization of R&D and management of technology will be addressed in greater depth.

5.1 Marketing and sales

95% of Reson's turnover is generated in the export markets, of which the U.S. is the most important one. Generally, Reson has strong market positions in North and South America, East Asia and Western Europe, while the position is relatively weak in Africa, Russia and the other former Soviet republics, New Zealand and Australia. Generally however, there is from year to year quite significant fluctuations with respect to the relative sales in different countries.

As previously mentioned, the larger part of the sales stems from the sonar system market, and only a minor parts from the high power ultrasonics market and the transducer and hydrophone market. The relative distribution of sonar systems sales between the three sub-markets, hydrographic surveying, off-shore and military, is also subject of substantial fluctuation.

Markets and globalization

Export was initiated already with the first product, the homogenizer for heating and electricity plants. Reson began to export the homogenizers to nearby markets such as Scandinavia, Germany and Switzerland. Later, Reson also exported the homogenizer to Japan.

Today, Reson has offices in Denmark, Santa Barbara USA, Aberdeen United Kingdom and representatives in Belguim, China, Cyprus, France, Germany, Hong Kong, Indonesia, Japan, the Netherlands, the Philippines, Poland, Russia, Saudi Arabia, Singapore, South Africa, South Korea, and Taiwan. Reson's worldwide network of offices and representatives provides information and some technical support and service to local users and customers. However, only very few of the representatives are capable of providing the technical support and service themselves. Their primary function is to accumulate and apply knowledge about their local community and business culture, to establish contacts with potential customers and to monitor the markets. However, when a deal is at sight, staff from Reson takes over.

Despite Reson's relatively small size, it is of crucial importance to operate on a global level. First, the short window of opportunity requires a quick and simultaneous market penetration globally in order for product development to be commercially viable. Secondly, globalization contributes to equalize the effects of substantial market fluctuations which characterizes several of Reson's product markets.

Organization of the sales effort

In the beginning, sales and marketing efforts were mainly performed by Reson's technicians. By the early 1990s, it became obvious that Reson lacked a professional and dedicated sales force who could concentrate one hundred percent on marketing and selling products. Since then, Reson has established a professional sales force both in Santa Barbara and in Denmark. The diversified character of Reson's product portfolio makes it, furthermore, necessary to build specialized capabilities in sales within - for such a relative small organization – a significant number of product markets. This is reflected in the sales organization by a very a high degree of specialization and consequently division of areas of responsibility between the employees.

This professionalization of the sales function also reflected and reinforced the movement away from the previous dependence on highly customized products.

Alliances/ license agreement

When the homogenizer for ship engines was introduced, Reson had not yet established appropriate production facilities, and Reson was immediately confronted with significant barriers to the market, due - among other things - to very costly and complex certification requirements. This provided the rationale for the very first strategic alliance - in the form of a license agreement with a Swedish company (c.f. section 2).

In 1997, Reson and MAN B&W entered an agreement according to which MAN B&W will sell the Reson homogenizers worldwide (c.f. section 3.1). In contrast to the licence agreement with the Swedish company, this agreement does not give away exclusive rights, but the two agreements have one thing in common: to provide momentum for market inroads that would otherwise be impossible or highly difficult for Reson to pursue alone.

Besides alliances to overcome market barriers Reson is engaged in close cooperation with a number of suppliers and lead-users (c.f. section 5.2 and 6.1), academic institutions and occasionally even with competitors concerning production and R&D activities (see section 6.1).

5.2 Production

Reson is rooted in a project organization focused on customized products and was therefore not geared for standardized production routines. The first time Reson was faced with the need to organize large-scale production, it acted like most project organizations - it decided to outsource most of its production activities and only run a limited assembly and test function in-house. Today, Reson still makes extensive use of component suppliers and deliberately uses second sourcing, when possible, in order to reduce the risk of becoming too dependent on a single supplier. Second sourcing is particularly difficult to ensure when Reson is geographically restricted in its choice of suppliers due to, for example, transportation costs, and at the same time is in need for suppliers with very specialized knowledge and equipment. This is the case for the supply of the bodies in cast iron for homogenizers. Here, it is very difficult, especially in the Danish context, to find alternative suppliers, because very specialized equipment is required to be able to handle the relative big units in cast iron. On the other hand, it is too expensive (due to logistics costs) to choose a supplier very remote from Reson's production facilities in Denmark. The role of suppliers in Reson's product development is discussed in section 6.1.

Contrary to the case some years ago, the assembly and test processes are now standardized and take place in certified production facilities both in Denmark and the U.S. Despite this change towards standardized production, Reson has preserved some of the characteristics of the project organization in production. As a result, there are no physical walls separating production and development activities. The philosophy is that sharing facilities and observing the activities that take place in the other departments increases interdepartmental interaction and therefore also mutual respect. The tangible benefits are, on the one hand, that problems in production that are caused by features associated with new or modified products are solved faster, and, on the other hand, that product development is more likely to be designed for feasible manufacturability.

5.3 Finance

In the first years, Reson was very dependent on access to external funding, e.g. from the Ministry of Environment and Energy and the Danish Agency for Trade and Industry (under the Ministry of Trade and Industry). The close cooperation and contacts with Professor Bjørnø and his colleagues at the Technical University of Denmark opened many doors for Reson, and facilitated access to public funds. Reson in fact provides a case in which public (national and EU) funding of R&D and related activities has contributed remarkably in creating a company with world-class competencies. Reson has continued extensive use of public funding for its R&D activities (see section 6.2)

In 1992 Reson invited two venture companies to invest in the company: Dansk Kapitalanlæg and Dansk Erhvervsinvestering. The two companies provided Reson with 18 mil. DKK in venture capital. Today the three Reson-brothers own 53% of the shares, and the two venture companies 41%.

6. The organization of innovation and technological development

In order better to understand the organization of innovation and technical development in Reson, one has to acknowledge not only the internal organization of Reson's R&D-activities, but also the tremendous importance of external parties and the way Reson deals with these.

Section 6.1 provides an outline of the organization of Reson's external relations of critical importance for innovation and technical development. The role of one particular type of external partner, the public funding partner, is discussed in section 6.2. In section 6.3 we briefly introduce Reson's approach to project management. Section 6.4 deals with the latest development in the R&D staff and tries to map Reson's technological capabilities and their affiliation with the three different product markets, as well as their location in the Danish unit and/or the Santa Barbara unit. Finally section 6.5 outlines the changes in Reson's patent policy over the last two decades.

6.1 Sources of inspiration and knowledge

Most of the innovation and technical development activities taking place in Reson draw on a large number of external sources of inspiration and knowledge

(Figure 8). Below we shall describe the way Reson deals with the most important external sources: lead-customers, innovative suppliers, and academia.

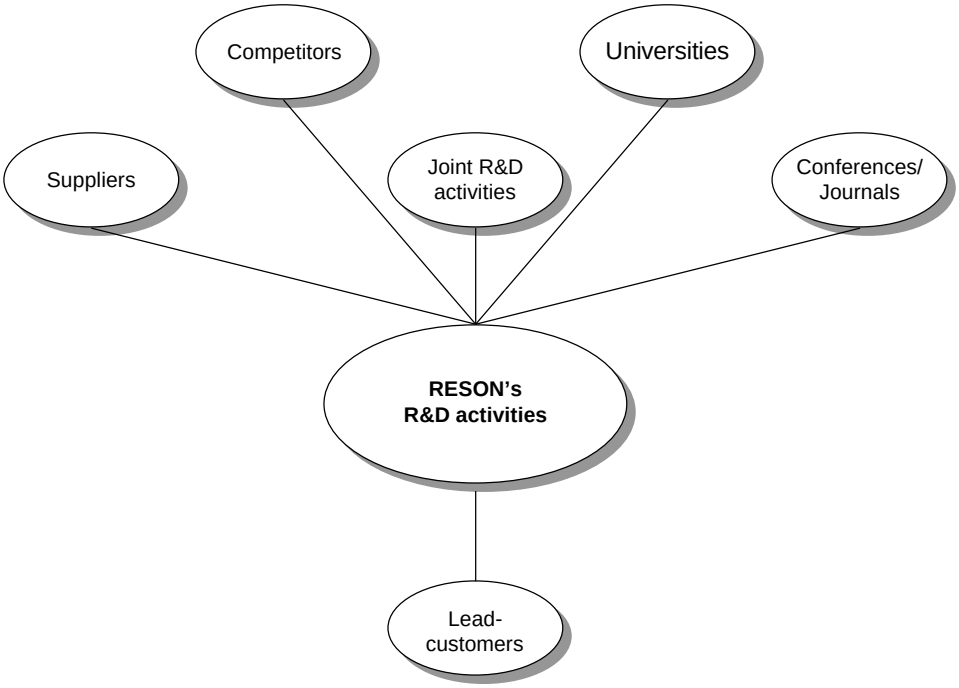

Figure 8: Reson's sources of inspiration and knowledge

Lead-customers

As mentioned earlier, Reson was created as an indisputable technology-driven venture, but during its two decades of existence, Reson has developed into a predominantly market-driven – although still technology-based - organization. A clear indication of this development is that users and customers[12] by now are considered to be the most important source of inspiration for product development together with innovative suppliers of components (see the following sub-section). This significance is clearly expressed by the energy Reson puts into establishing close links with a few main customers - especially the customers with the most advanced needs[13].

[12] Even if there are often distinct differences between the role of users and the role of customers, we do not differentiate here, but apply the term customer to comprise both customer and user.

[13] All new products are initiated and developed in close cooperation with the customers. Even if Reson markets its products globally, the main inspiration for developing new products and product features is collected from customers based in Northern Europe. According to Reson, this customer segment possesses

However, in its early years, Reson also learned the lesson of the down-side of "excessive" customization. In this period, Reson found itself in a situation where almost every delivery differed from the previous one. Therefore, Reson was not able to fully exploit the commercial potential of its products/solutions, or to capture scale advantages from standardizing already developed products. The result was declining profit rates. Having learned this lesson, management now recognizes that one of the main challenges of being market-driven is the ability to pool the needs of customers. As a result Reson has adopted an approach where it in principle only offers standardized solutions, except for the few selected customers that Reson considers lead-customers. It is mainly from these few customers that Reson collects more detailed information about needs for new or improved features.

Quite often, the actual product development is a highly interactive process in which selected customers play a vital role in giving feedback on early versions and participating in building prototypes. Earlier, the role as lead-customers was mainly played by the different naval buyers. However, due to the end of the Cold War, the navies are no longer in a financial position to play the role as the driving force in the technological development of sonar systems. During the 1990s, both the offshore industry and cable laying companies have articulated very advanced requirements for the functionality of sonar systems. For Reson, close cooperation with companies from these industries has been instrumental in maintaining Reson's position at the technological edge[14].

The interaction between customers and Reson's R&D staff is not exclusively centered around well specified development activities, but also includes more open-ended activities such as the R&D staff's contribution to problem-solving for already sold and installed solutions. Through these relations, the R&D staff gets hands-on experience with the specific conditions under which their products are used.

Suppliers

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the most advanced needs and the best capacity to articulate those needs – also compared to the U.S. market. Moreover, Reson experiences no cultural barriers in communicating with customers from Northern Europe, and thus, Reson's R&D staff finds it easier to interact with customers from Northern Europe compared with customers from e.g. Eastern Europe or the Far East.

[14] Since the navies increasingly prefer to buy COTS-products, the same basic parts and technologies can be sold both for navy use and civilian use.

Like its competitors Reson buys some of the vital components and materials for its products from specialized suppliers (e.g. chips for the sonar-systems or the materials used as the acoustic ”engine” in transducers). Some of the components have a significant influence on the performance and features of the final products.

Since all the manufacturers of sonar systems in principle have access to the same components, it is very difficult for any of them to create sustainable competitive advantages. Still, due to the very short life cycles in this business, one firm can gain a relatively significant lead-time advantage from just being the first to implement and thus exploit the features of a new version of a core component into an end-product. In order to attain this kind of lead-time advantage, it is very important to have a good window into the innovative end of the relevant component suppliers and, ideally, be aware of the opportunities so early that it is possible to exploit the opportunities for end-product development created by improvements in a core component from the day the new or improved component is released.

Since the industries to which the suppliers of some of the core components belong are highly dynamic and characterized by a large number of companies (including new entrants) who - to some extent - take the technological lead in turn, it is no trivial task to monitor their innovative efforts. However, since the advanced end of these industries to a large extent is located within the Silicon Valley area, Reson has, via its Santa Barbara section, privileged access to early knowledge about which new component features are in the pipeline, and this makes proactive adaption to the future component situation possible. This window into the supplier industry is reinforced by the fact that Reson is involved in close cooperation with some innovative suppliers.

The direct access to the informal professional supplier network in the Silicon Valley area means that Reson has knowledge about prospects for new components about 1 1/2 years before Reson would have known had Reson only been located in Denmark.

Relations with academia

Since its foundation, Reson’s relations with the academic community - in the beginning especially with the Technical University of Denmark - have played a vital

and stimulating role, e.g. as partners in projects, as a source of specialized knowledge, as a door-opener and as a supplier of R&D engineers. With respect to the latter role, Reson acknowledges that the R&D department also has to function as an on-the-job-training platform for newly recruited engineers. Some of the highly specialized skills required by Reson are rarely obtainable directly from university - at least not in Denmark - but have to be acquired on the job[15]. Therefore, Reson is deliberately trying to recruit engineering students for thesis-writing within fields of interest for Reson. Apart from the potential advantage of early on-the-job-training and good specialization, such student recruitment may add creative inputs to Reson's R&D department.

Today, Reson cooperates with a number of universities around the world within Reson's main technological disciplines, and the R&D staff participates on a regular basis in both academic and more practically oriented conferences[16].

[15] There is no program in Denmark targeted at educating engineers in acoustic mechanics. Consequently, Reson is forced to hire engineers with a background in general mechanical engineering and train them in the special field of acoustic mechanics.

[16] So far, however, Reson staff has never given presentations at these occasions. This has neither been due to poor competitiveness of the knowledge in question nor to any special considerations concerning confidentiality. Rather, it has been considered of no value to Reson. However, the managers at Reson have recently sensed an increasing pressure especially from partners in joint project and funding agencies to disclose more knowledge to the partners.

6.2 The role of public R&D funding programs

Since its very early years of existence Reson has made extensive use of a wide range of Danish and EU R&D funding programs. Reson's management staff developed considerable skills in how to approach and apply for grants from public Danish sources, and for several years participation in such programs contributed considerably to the overall annual turnover. Many of the projects were joint projects with professor Bjørnø and his colleagues from the Department of Manufacturing Engineering at the Technical University of Denmark. Not all these projects were close to Reson's core activities nor linked to commercial prospects in the shorter term. However, the diversity of projects contributed to create a very strong knowledge base in Reson about the basic principles of ultrasonic transducers and support technologies.

During recent years, Reson has increasingly been engaged in EU-funded programs. These programs basically require participation from a number of companies across Europe and a combination of firms and academic institutions. This structure means that the participating firms not only gain from the knowledge accumulation within the project, but also from having access to an expanded network. Hence, they can potentially learn from all the partners in the project, even in matters outside the specific project issue in question, and to learn to cooperate with R&D departments in other companies. In Reson, the networks established through these cross-European R&D-projects are considered highly valuable - not least because they facilitate informal access directly to the R&D departments of the partners. This saves time and resources in inter-firm relations and makes it possible, for instance, to bypass top management or sales staff who wants to sell standard solutions.

Whereas Reson, in the beginning, tended to initiate nearly whatever projects that could be sponsored entirely or partly by a public source, the tendency today is to try to influence the content of future programs in order to increase the benefit Reson can gain from participating in the program later on. Furthermore, Reson is much more selective about which projects to engage in. However, the aim remains to have a substantial participation in research programs sponsored by Danish or EU R&D-

programs[17]. This combination of internal and external sources leaves more room for risk-taking than would have been acceptable if only internal Reson funding was at stake.

As more and more firms are able to and do produce very qualified proposals, the competition for public funding has been growing during the last years. However, Reson's many years of experience with publicly funded R&D projects provides Reson with an advantage in the competition for further public funding. Most importantly, Reson has been able to establish a good network of potential international partners and has accumulated knowledge and efficient routines in producing proposals according to requirements.

6.3 Project management - milestone versus autonomy approach[18]

Reson has faced the challenge of an ever shortening window of opportunity[19] by: 1) establishing procedures that enables fast reaction to new business opportunities (primarily within the existing product markets) and 2) focusing on developing new products as fast as possible and within the agreed deadlines.

Reacting to opportunities: Because it is very important for the company to be able to react quickly to new opportunities, Reson has found it appropriate to implement a bottom-up approach to product development, implying that both decision-authority and resources – once a project is approved - are decentralized to the individual R&D engineer. The strengths of this approach are that the individual engineers involved in executing a project can adapt continuously to changes, in for example the customer preferences and the supply of new components.

Reduction of time of development: Reson has already managed to reduce the average time spend on development of new products from 2 to less than 1 year. The ambition is to reduce it even further[20]. Reson tries to meet this objective by focusing

[17] Reson conceives itself as relatively successful in obtaining external funding with a total of 15 projects during the last 6 years. On average external funding has contributed with more than 4 mill DKK per year.

[18] Reson cooperates with IMD (International Institute for Management Development) and MIT (Massachusetts Institute of Technology) about finding new ways to manage development projects.

[19] Currently the opportunity window for most of Reson's products is less than 2 years.

[20] Obviously, the ever increasing technological complexity is a counteracting force against this ambition.

strongly on the last stages of the product development process. This is due to the experience that most projects follow the same pattern in which the milestones are met during the first 90% of the project period, while they fail to meet the milestones for the last 10% of the planned period.

In order to increase the rate of projects that deliver on schedule, Reson has left the conventional milestone management approach and introduced a new approach which focuses exclusively on the ultimate deadline. Parallel to this focus on the ultimate deadline, the project management has been given more freedom to sequence the activities and allocate resources within the project period.

6.4 The R&D staff and technological capabilities

During the last 2-3 years, the R&D staff has undergone a high turnover and a net increase of 50 %. Today, the engineering staff's average age is around 32 years.

The turnover in staff was necessary because the composition of skills did not any longer fully reflect the needed capabilities. For example, it was necessary to acquire skills/capabilities within signal and picture analysis (a combined software and geological capability), new materials technology and general software engineering. Furthermore, Reson faced a technological reality which increasingly required an academically trained staff. In other words, the predominantly experience-based knowledge is increasingly to be aligned with a solid theoretical foundation to provide a strong basis for exploiting the technological opportunities of today.

Reson employs a wide range of technological capabilities for developing and producing its products. As illustrated in Figure 9 almost all capabilities bear some importance to all three product groups, however the relative importance differs from technology to technology across the three product groups.

Capabilities:	Sonar systems	Transducers and Hydrophones	High Power Ultrasonics
Acoustic technology: • simulation • modeling • underwater acoustics			
Electronics and signal handling: • communication technology*)♣ • analog technology • digital technology♣ • high power circuits♦ • soft- and firmware development♣			
Material technology: • polymer technologies (e.g. glues, vulcanization)♦ • acoustic engines♦			
Mechanic construction: • simulation • modeling • structural analysis♦ • corrosion processes♦	( )		

Figure 9: Technological capabilities in Reson.

*Technologies relevant for gathering and transmitting data.

Capabilities marked ♦ are mainly located in the Danish R&D department, while capabilities marked with ♣ primarily are located in the U.S. R&D department. The unmarked capabilities are shared between the offices and cannot be said to be more present in one of the two offices. This division of areas of interest between the two R&D units limits the need for coordination of activities between the two units. However, almost all development projects within the field of sonar systems involve employees from both the U.S. and Denmark, while the development projects within the other two product areas are carried out by R&D personnel in Denmark. The need for coordination in the joint sonar projects is reduced by a very strong attention to clarifying the technical interfaces between distinct modules in the projects, for example the interface between the electronic and mechanical engineering parts of the projects. This implies that all projects are specified in detail in terms of task modules

before take off, and that units in Denmark and the U.S. can work rather independently without much managerial coordination.

The capability clusters associated with "acoustic technology" and "electronics and signal handling" are the most decisive for competitiveness in the product markets where Reson operates. It is also within these two clusters – particularly with regard to sonar systems and transducers and hydrophones - that Reson holds its strongest position. Thus, it is the ability to combine the different technological capabilities within these clusters and align them with in-depth knowledge of the application areas, that comes close to being a core competence.

Recently, modeling has become a very important approach to the development of new products and product features. Today, Reson can predict with a very high degree of precision how a given function should be designed. This saves considerable time compared to previous procedures of trial-and-error learning processes. The increased value of modeling in development can be explained by the dramatic increase in calculation power of modern computers.

6.5 Patent policy

In the beginning of the 1990s, Reson was among the top ten most patent-active companies in Denmark. This urge to file a patent application for every new patentable invention is quite natural in light of the economic benefit Reson gained from patenting its first invention - the homogenizer. However, it later became clear to the management that the economic payoff from the patents in that period was rather poor and could not at all justify the high cost of applying for, and later on enforcing the property rights of, the patents. There are several reasons for this:

- Firms exploiting ultrasonic technologies face a high risk of having their patent applications turned down with reference to very old and broad patents from the childhood of ultrasonics[21].

[21] As early as the late part of the 19th century when the acoustics technology was still at a very immature level many academic researchers filed and received patents on the basis of what later proved to be very general principles within this technology. These early and broadly defined patents today block the opportunities for patenting inventions that somehow rely on these general principles.

- It is generally considered very difficult and costly to obtain a patent which competitors in the industry cannot invent around.
- The window of opportunity is very short implying that the economic rents from an invention have to be captured within very few years.

As a consequence, the patent policy in Reson has changed, and today the company only files applications for patents after serious considerations. Generally, it believes that it can be protected long enough to harvest the economic benefit by keeping knowledge secret. Despite this change in patent policy, it is still recognized that if Reson once again comes up with an invention as original and new as the homogenizer was, the firm will again file a patent application.

7. Concluding remarks

This case-study illustrates how a technology-based entrepreneurial company has managed, during its more than two decades of existence, to grow from a small start-up company to a medium-sized company which is among the globally leading companies within most of its business areas.

On the one hand, the case demonstrates how a dynamic company such as Reson within its relatively short life time has changed dramatically in a number of dimensions:

* From a strongly technology-driven strategy of innovation and diversification to a much more market-driven strategy of incremental change.
* From a focus on highly customized products to a focus on standardized products.
* From an exclusive product focus on homogenizers (and high power ultrasonics) to a primary focus on sonar systems.
* From a primarily Danish focus to a much more global focus in both sales and sourcing of technical and market knowledge.
* From a purely innovative project-based organization to a much more functional, professionalized and routinized organization.

On the other hand, despite these dramatic changes, Reson has also maintained distinct features from its early days:

- The very informal and innovative culture with a short distance from bottom to top.
- The strong focus on maintaining and developing value-creating relations to external parties (lead-customers, innovative suppliers, universities, etc.).
- Maintaining a high degree of flexibility through an extensive outsourcing strategy.
- Exploiting public funding for competence development.
- Quickly responding to new opportunities.

CEO Claus Steenstrup summarized as follows:

> *"that the main difference between Reson's situation today and when we founded the company is that we are much better at creating and interpreting the environment. And we are better at exploiting the chances."*

Finally, the case illustrates how a small and medium-sized company can compete in a knowledge-intensive, global industry against much larger and financially powerful competitors. Certainly the informal, entrepreneurial and innovative culture, the flexibility and the ability to respond quickly to new opportunities are all important elements in the competitive success of Reson. However, the case also identifies distinct organizational competencies in dealing with external and internal technical and market capabilities. Reson has been able to catalyze innovation within sonar systems and transducer technology by integrating and developing external and internal capabilities. First, by creatively linking technological and market opportunities provided from the most advanced suppliers and external centers of excellence (i.e. universities) and the quality and cost requirements from customers – especially lead-customers. Secondly, by exploiting synergies between the different technological capabilities in Reson's technology base (including synergies between the Danish and the U.S. R&D units) and the market or application capabilities associated with possessing in-depth knowledge of the markets of high power ultrasonics, transducers and hydrophones, and sonar systems.

Everything that Reson makes is based on sound waves moving through fluids, and it is around this category of technical functionality and its corresponding market applications that Reson has built a strong core competence. This core competence (and its constituent technical and market capabilities) would become a core rigidity, if a radical new technology based on another carrier than sound waves (e.g. magnetism or light) for underwater image creation emerged in the future. However, in the foreseeable future there are no likely substitution candidate around the corner, and were a threat of this kind to show up, Reson would be likely to grasp this as yet another new opportunity to grow and learn.

Appendix 1

The case-study is based on interviews conducted by the authors spanning more than one decade:

- two interviews conducted by Jens Frøslev Christensen in the spring of 1987 and the autumn of 1991 (see Reson-case in Jens Frøslev Christensen: Produktinnovation – proces og strategi, Handelshøjskolens Forlag 1995) with Claus Steenstrup, Managing Director,
- six interviews conducted by Kenneth Husted in the summer of 1994 with Claus Stenstrup, Managing Director, Steen Bruun, R&D Manager, and Kim Christiansen, Sales- and Marketing manager,
- three interviews conducted by Kenneth Husted in 1998 with Claus Stenstrup og Steen Bruun (7 September), Steen Bruun (18 and 24 September),
- one interview conducted by Jens Frøslev Christensen and Kenneth Husted in 1998 with Steen Bruun (8 December).