Building FORCE Technology:
shaping a technology-based service provider, 1940-2005

The current transformation of Western industrial societies is inducing increasing prominence to new values and competences in technology-based businesses in order to maintain competitiveness. This was noted by FORCE Technology’s managing director, Ernst Tiedemann at a meeting at the Danish Academy for the Technical Sciences in 2003.\(^1\) The traditional industrial societies were based upon mass production, and automation and standardisation were keys to richness. Tiedemann stressed that tough technology will remain essential, technical expertise will not sufficient. Close relations with customers and mutual trust will be critical and partnerships with risk sharing between supplier and customer will be formed with growing frequency. The company’s ability to use this more complex interrelation requires more emphasis on marketing than previously, where the focus was exclusively on products, equipment for production and development of employee competences.

Tiedemann talked about FORCE Technology, but his contribution had a wider perspective for the current situation in Western industrialised societies. Industrial mass production is being relocated to low-income countries, but the relocation also encompasses knowledge tasks like programming and industrial design that is far more challenging for Western companies and societies.

Ernst Tiedemann’s vision was based upon his experience at the Danish service provider FORCE Technology, which never had substantial production of goods. Therefore, this company was not compelled by the economic internationalisation to relocate production to low-income countries - or refocus its business. However, the economic internationalisation and technological change caused FORCE to refocus their business and improve management in


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the last thirty years. In this period, the company grew from an exclusively Danish company to an international corporation with eight foreign subsidiaries in Europe and the Americas. This experience makes FORCE well suited for analysing the interacting development of management and technology, as the scope of its services grew beyond traditional engineering.²

The Danish Welding Institute 1940-1970

The Danish Welding Institute (Svejsecentralen in Danish) was established in 1940 to facilitate control of welds and improve welding. In the 1930s, steel elements were rivetted to build ships, bridges etc. Welding was an attractive alternative way to join steel elements together. Welding enabled economizing on steel, as the steel elements only needed to meet, while rivetting required overlap of steel. Further, two men were needed for rivetting, a riveter and a holder-on, to compare with one welder. However, it was not possible to assess the quality of a weld through visual inspection, and some time welding seams came apart, which could be fatal. To compare, inspection of rivets was simple and many independent rivets were used for each joint. Therefore, a few bad rivets did not cause a bridge to collapse.

People worked in the 1930s to solve the quality problem of welding through standardisation and quality control. The first German welding standard was published in 1934. In 1937, the Danish association of university trained engineers (Ingeniørforeningen) and the Danish Standardisation Institute (Dansk Standardiseringsraad, today: Dansk Standard) started to establish Danish welding standards.³ At this time X-rays were applied for inspection of welding in Germany, Sweden and the Netherlands. Based upon these observations, Anker Engelund took the initiative to acquire a mobile X-ray devise to inspect welds across the country. Engelund was professor of bridge construction at Technical University of Denmark (Danmarks tekniske Højskole).⁴

². So far this development has been analysed either through studies of the dynamics of technology or corporate governance. The former studies can be exemplified by Thomas Hughes, Rescuing Prometheus, New York: Vintage Books, 1998. The latter by Alfred D. Chandler, Scale and Scope. The Dynamics of Industrial Capitalism, Cambridge, Massachusetts: Harvard University Press, 1990.


The X-ray equipment was installed in a van and became operational in early 1940. The equipment was paid by a grant from a private Danish foundation, and the plan was to pay its costs of operation from fees for X-ray control of welds, for example, at Danish Shipyards and power plants. The welding inspection operation was organised as an independent office at Engelund’s institute at Technical University of Denmark in København that provided a weak setting. At that time this activity was beyond what the publicly financed universities were allowed to engage in.

The weakness of the organisational setting is illustrated by the fact that there was not any financial transaction between the welding inspection operation and the university, but the operation enjoyed free housing at the university and borrowed equipment. Further, by the end of 1940, there was a deficit in the operation, which the university could not alleviate, and Engelund turned to private Danish foundations for contributions. However, as fund raising took time, the cash deficit at the end of the year was filled through a personal loan from professor Engelund. Engelund’s loan was returned, as soon as the welding control operation was awarded funds from a foundation.

The affiliation problem was settled by end of 1940. The welding inspection activity was reorganised as the Danish Welding Institute (Svejsecentralen), a private foundation which became a research subsidiary of the Danish Academy for the Technical Sciences (Akademiet for de tekniske Videnskaber). The Academy was a private organisation that had been established in 1937 to promote technology research and transfer to Danish industries of new Danish and foreign research results. A key activity for the Academy was to house research activities, which were organised as separate private foundations according to research field. Each foundation raised funds to cover their expenses from various sources and earned revenues by providing services. The Academy stressed the role of research, and its main contributions to its research subsidiaries were to facilitate contacts to Danish and international research insti-

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Den tekniske Forenings Tidsskrift, March 1941.

5. Report on the welding control operation from January-August 1940, box 1, Vinter papers, FORCE archives.
6. For example, DTU acquired equipment to be used for the welding inspection operation, Welding Institute board meeting 11 February 1971, board papers, FORCE archives.
7. Report on the welding control operation in 1940, box 1, Vinter papers, FORCE archives; minutes board meeting 17 December 1940, board papers, FORCE archives.
8. Statutes for the Danish Welding Institute, 25 October 1940, board papers, FORCE archives.
tutions, Danish industries and Danish authorities, and to appoint the subsidiaries’ boards of directors. The Welding Institute distinguished from the Academy’s other research subsidiaries by having strong revenues from certification of welds.

The Welding Institute’s new affiliation caused its activities to be extended to include research. Since, this institute developed and promoted welding standards in Denmark and for more than 30 years it was the exclusive Danish institution certifying welding. Further, the Danish Welding Institute distinguished from most similar institutes abroad by not training welding operators. Since 1911, this was accomplished by the Technological Institute in København.

The Welding Institute certified according to Danish welding standards in 1940 and according to Swedish standards in 1942, which was essential to facilitate export to Sweden of welded items. In 1946 the institute was authorised to certify according to the standards of Lloyds of London. This opened for insurance of completely welded ships, essential for the production at the many Danish shipyards of that time. The authorisation to certify according diverse standards were the result of a combination of factors. First, the quality of the welding institute’s work and their contribution to the development of Danish welding standards. Second, contacts to key authorities in Denmark and abroad mediated through the good offices of the Danish Academy of the Technical Sciences and the Technical University of Denmark. Third, the Welding Institute established close contacts with welding institutes and welding related research institutions abroad. During the Second World War their contacts were confined to Germany, the Netherlands and Sweden. After the end of the war, contacts were quickly established beyond the former German controlled Europe to among others England. The Danish Welding Institute was a member of several international organisations, the International Institute of Welding in London (1949) and the International Testing and Inspecting Association (1957). Forth, the Danish Welding Institute’s position as the first mover in this field was important, as extensive transnational welding certification was beyond imagination at that time.

The accounts until 1952 show that the Welding institute had problems earning revenues to cover expenses, and they frequently received funds from foundations and contributions from

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9. Draft report on activities in 1946 (December 1946), board papers, FORCE Archives.
10. Board meeting minutes, 8 March 1949; enclosures to Welding Institute board meeting, 8 May 1957, board papers, FORCE archives.
the Danish steel industries, and the Technical University of Denmark provided free housing and several times contributed new equipment. These results reflected the difficulties of the Danish industry in the years just after the Second World War.

Similarly, the growth of the Danish industries in the 1950s and 1960s reflected steadily increasing activities at the Welding Institute. Their revenues grew from $43,000 (DKK 0.3 million) in 1950 to $1.5 million (DKK 13.5 million) in 1970 i.e. by factor of 23.11

Until the 1960s, the scope of assignments grew slowly. First, already in 1940 by the establishment of the Welding Institute, they added consulting on welding to their control operations.12 Second, they improved existing methods and adopted additional methods to test welding with a similar scope as X-rays, ultrasound (1945) and recording based upon radioisotopes (1950), which enabled testing of welds where x-rays were not reliable. Second, they started to develop ultrasonic measuring equipment for areas beyond welding: Equipment to measure the fat and meat of pigs at bacon factories (1961), equipment to handle radioisotopes in various industries (1961) and ultrasonic human medical equipment (1966). However, they did not establish industry-style production of this equipment, and they had problems earning reasonable from this activity.13

**Government support and national consolidation 1970-92**

In 1970 the Danish Ministry for Trade and Industries sat up two commissions to map the technological service in Denmark. This reflected an emerging government commitment to industrial development. Previously the government’s industrial commitment only encompassed international trade agreements, trade, borrowing requirements, training and curtailed state testing of artifacts in a few essential fields, like testing of pressure bottles and means for fire protection.

The first of the ministerial commissions mapped technological service activities in Denmark

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12. Statutes for the Danish Welding Institute, 25 October 1940, board papers, FORCE archives.
aimed at diffusing results from technology science and development in Denmark and abroad for application in industries and the public sector. Their report from 1972 suggested to expand the range and size of the existing technological service mainly aimed at small and medium-size companies. So far these technological service activities had been carried out by a few public institutions, mainly the technological institutes in København and Århus. The report recommended increasing the government funding and extending the range of the government supported technological service organisations that needed either to be public institutions or non-profit self-governing bodies. The commission’s recommendations were implemented in an act adopted by parliament in 1973.\textsuperscript{14}

The same year, the report from the second commission on technological service was also implemented as a parliament act. So far the government testing institution (Statsprøveanstalten) had had exclusive rights to state authorised testing, which had limited scope and scale.\textsuperscript{15} These acts were subsequently amended but the basic principles remained.\textsuperscript{16}

The two acts on technological service from 1973 gave the Welding Institute new possibilities. The following year, the institution applied for and was authorised to certify welders and welding.\textsuperscript{17} Simultaneously, they started to produce technological service mainly for small and medium-sized companies.

The Welding Institute’s participation in government supported technological service provided formal relations to the other private and public institutions in the new national technology service system and to the Ministry for Trade and Industry, which administered these acts and their successors.\textsuperscript{18} Already before the enactments, the Welding Institute’s director Lars Herman Larsen, had established productive co-operation with Morten Knudsen, who was director of the Technological Institute in København. First, they organised co-operation between their welding activities between 1971 and 1976. Then the Technological Institute surrendered its welding activities to the Welding Institute, as a part of the Technological Institute

\textsuperscript{14} Teknologisk service. Handelsministeriets udvalg vedrørende teknologisk servicevirksomhed, København 1972; “Lov om teknologisk service”, lov nr.142 (March 1973).


\textsuperscript{16} Latest act in this field: Lov om teknologi og innovation, lov nr.419 (June 2002).

\textsuperscript{17} Minutes, Welding Institute board meeting, 24 October 1975, board papers, FORCE archives.

\textsuperscript{18} The Danish Ministry for Trade and Industry has changed name several times. In 2001, technology service moved to the Ministry for Science.
Institute’s efforts to focus its activities.\textsuperscript{19}

The Jutland Technological Institute in Århus became the second actor in welding certification in 1971. The technological Institute in Copenhagen had trained welding operators since 1911, and the Århus institute had started similar training activities shortly after the institute was established in 1941. But neither of the institutes had worked in certification of welding, until the Århus institute decided to do so in 1971, which made them a competitor to the Welding Institute. They applied for authorisation before the adoption by parliament of the acts of 1973, but their application was filed after the establishment of the two commissions in 1970, which signalled opening beyond the current technology service institutions.\textsuperscript{20}

The outcome was competition as the growth of welding in Danish industries declined and as training of welding operators gradually was adopted by local public technical schools across the country, which reduced the Jutland institute’s activities in this field. The competition remained until the Welding Institute in 1987 bought the Jutland institute’s welding activities. These activities were not any longer profitable in Århus due to small scale of the certification activities and the competition form local technical schools in training welders.\textsuperscript{21}

The third welding certification actor was a small commercial brake-off from the Welding Institute.\textsuperscript{22} They also in 1971 applied for authorisation to certify welding, which opened for a discussion of the requisites of organisations that could be awarded state authorisation for technological testing. The Welding Institute found such an organisation should be impartial, financially independent and having a board with representatives from industry and public supervising authorities.\textsuperscript{23} The small commercial firm did not fulfill these requirements, but the requirements resembled the demands to attain state authorisation in the law on technology service from 1973, two years later. This was no co-incidence, as the Welding Institute direc-

ctor, Lars Herman Larsen, as was a member of the commission that came to lay the foundation for that law. These demands ensured the quality of welding control, but they also limited competition in Denmark. Anyway, the small commercial company got the authorisation. Subsequently, the company was merged into the big engineering consultancy company Carl Bro. In 2001, the Welding Institute bought Carl Bro’s certification activities and came to have all Danish welding certification activities.24

Starting in the early 1970s, the Welding Institute also established co-operative activities with the technological service institutions in neighbouring fields. Since 1971, there was cooperation with the Danish Corrosion Centre (Korrosionscentralen). The Corrosion Centre was a research institution that focussed on corrosion of metals and complemented the Welding Institute in metallurgy, essential to understand decay of welding. It was also affiliated with the Academy of the Technical Sciences and it had been established in 1965. In 1973, the Corrosion Centre moved into premises in the Welding Institute’s buildings in Brøndby, just west of København, but it remained independent of the Welding Institute. During the 1970s and 1980s, the two institutions cooperated extensively, but they learned that there are limitations in cooperation between separate institutions. For example, they cooperated on corrosion and metallurgy where their competences were complementary. However, they encountered problems when they tried to acquire and operate a laser in common in 1987.25 This was one reason that the two institution merged in 1990 with the Welding Institute as the continuing institution. The other problem was low productivity, which was solved subsequently as the Welding Institute required higher productivity. Simultaneously, the Welding Institute merged with the Danish Isotope Centre (Isotopcentralen), a third affiliate of the Academy for the Technical Sciences. The Isotope Centre had been established in 1957 and focussed on promoting the use of radioisotopes in Denmark. Their radioisotope competences complemented those at the Welding Institute.26

These mergers were also the result of the Ministry for Trade and Industry’s policy in the late 1980s to merge the technological service institutions. In 1989, the Ministry tried to merge

24. Letter, FORCE to Carl Bro customers, 7 December 2000, board correspondence 2000, board papers, FORCE archives; Minutes, Welding Institute board meeting, 2 April 2001, p.6, board papers, FORCE archives.
25. Minutes, Welding Institute board meeting, 18 November 1970, p.4-4, board papers, FORCE archives.
the Welding Institute with the two technological institutes in København and Århus. This effort failed due to opposition in key steel industries, and a part of their effective protests was coordinated from Welding Institute’s boards.27

The goal appears to have been to establish a national technological champion to be able to boost Denmark’s technological performance compared to other nations, notably in the EEC. The goal resembled the subsequent construction of TeleDenmark and DONG (Dansk Olie og NaturGas, Danish oil and gas). TeleDanmark was established through nationalisation of the telephone monopoly in 1982, TeleDanmark (now TDC) and was sold to investors in the United States to fill the always slender Treasury. DONG is the national natural gas company established in the 1970. DONG is currently being boosted to become a big energy company, which the Treasury also can sell. True, a subsequent sale could fundamentally change the technological champion, but the objective was shared of all these endeavours to establish big companies and institutions in Denmark through domestic mergers. They should be big in order to be able to compete with big foreign companies and institutions.

Anyway, the Treasury paid for the mergers with the Corrosion Centre and the Isotope Centre, but the Welding Institute succeeded in fooling the efforts in the Ministry for Trade and Industry to extend the merger to encompass the big technological institutes in København and Århus. At the same time, the Welding Institute in 1991 merged with Dantest, formerly the government testing institution, which implied that the Welding Institute got additional testing tasks with state authorisation.28

The Welding Institute 1970-1990

During this period, the Welding Institute’s revenues rose form $1,5 million (DKK 13.3 million) in 1970 to $3,3 million (DKK 30.4 million) in 1990 i.e a growth by a factor of 3,3. The huge expansion was a combination of organic growth and mergers with other institution, and

27. Fax from deputy director Kurt Andersen, Odense Steel Shipyard, 19 Oct 1989, with copy of letter from director Troels Dilling, 18. October 1989, two key figures in the steel industry, Welding Institute board correspondence 1989, board papers, FORCE archives.

28. Minutes, Welding Institution board meeting, 27 March 1979, item 5, board papers, FORCE archives.
it reflected Danish industrial growth and extensive public funded construction projects. In the 1970s and 1980, the government and regional public authorities built oil and gas pipelines from the oil and gas fields in the Danish section of the North Sea, and a gas distribution grid in Denmark.

The Welding Institute’s activities were based on continued technological improvement and on bringing related technological fields under cultivation, as the welding related activities declined. Their decline was caused by the moving of building of ships and off-shore rigs to the Far East and the fizzling out of public funding of big construction projects in the mid 1980s.

In the 1970s, the Welding Institute’s continued technological development was enhanced through the phased merger with the welding activities of the Technological Institute in København (which moved to Høje Tåstrup at that time). The Welding Institute continued to develop technological equipment and they established a separate department for design of equipment in 1970. The most significant product between 1970 and 1990 was the ultrasound based P-Scan, which was developed in the late 1970s. It was an automatic inspection systems that could be adjusted for various purposes. It had world class, but the size of its development strained the weakly consolidated private institution, which also encountered problems gaining yielding contracts with relevant producers to earn revenues to cover the cost of developing it. However, P-Scan gradually became a success in many countries and it has been improved ever since and remains a key component of the Welding Institute’s product portfolio.29

The production and sale of P-Scan contributed to reshape the Welding Institute’s international network. Originally, this network originated in sharing of scientific information, but its purpose gradually changed to include business. In 1963, the Welding Institute joined the Eurotest consortium that was established to gain contracts abroad.30 This was a success and the Welding Institute gained contacts with Euratom and off-shore contracts in Persian Gulf. In 1967 the Welding Institute started also to gain contracts with Dutch and British off-shore activities in the North Sea. Subsequently, this provided extensive expertise when oil and gas exploration started the Danish part of the North Sea in the late 1970s.31 Here the authorities came to need Danish standards for quality control in building rigs etc. The Welding Institute

29. Minutes, Welding Institute board meeting, 18 November 1970, p.4-4, board papers, FORCE archives.
managed the writing of Danish welding norms based upon a substantial appropriation, and they subsequently managed the writing of common Scandinavian standards in the field based upon a second Danish appropriation. This was a major reason that the Welding Institute, in 1987, was elected by the representatives from the other EEC members to chair the newly established CEN (Comité Européenne de Normalisation) committee to write European welding standards. CEN standards became a significant component in the construction of the Single European Market between 1984 and 1993.32

The Welding Institute’s strong international contacts in Scandinavia and beyond made the institute consider in 1984 to expand in Norway.33 They analysed these markets but abandoned the idea due to the competition on this market. So far, the Scandinavian markets for welding control were national and there were no permanent presence of foreign operators in this field. The Welding Institute had transnational activities, but no permanent representation aboard, and the same applies for foreign operators in this field, which had activities in Denmark.

The general growth of the Welding Institute combined with the emerging oil and gas exploration in the Danish sector of the North Sea convinced the management to establish departments in Esbjerg (1981) and Ålborg (1982). In 1987 this was complemented with a department in Århus, as the Welding Institute acquired the welding activities of the Jutland Technological Institute. Training of welding operators was this Technological Institute’s main activity and they seeded the welding activities mainly, as their training operation was declining due to the local public technical schools taking over this activity. As this activity continued to decline, the department in Århus was closed in 1989. In 1990 and 1991 this nationwide structure was enhanced by the Welding Institute’s expansion of competences through the mergers with the Danish Isotope Centre, the Danish Corrosion Centre and Dantest.

The bigger scale and scope at the institute was reflected in its varying directors and changes in management and organisation. First, Hans Vinter was director from the origin in 1940 until 1969. He was a Master of Engineering from Technical University of Denmark and, often, he was referred to as lecturer at the Technical University, where he had welding instruction from 1952 to 1972, though he never held a permanent position and his main activity was as director of the Welding Institute. Winter was a weak director, completely focussed upon technical

32. Interview with Birger Hansen by Lars Heide, 1 March 2005.
Lars Herman Larsen was his successor. He was also a Master of Engineering from Technical University of Denmark. His leadership also focussed on the technology, but he established a wide contact network to the other technological service institutions and the Ministry for Trade and Industry and he improved the Welding Institute’s management. He managed the establishment of technological service for small and medium-size companies in the 1970s, which provided state subsidised revenues and gave access to information on technological development from a large number of companies. He established a formal committee of the departmental managers in 1974, and the following year he directed the process of constructing development plans for several years for all the departments, though until around 1990 the plans were only projections of existing activities.

Lars Herman Larsen chose to retire when he became 65 years old in 1990. However, shortly after he had informed his board, his management was severely stressed due to the costs of developing the P-Scan and as the German company, which had the contract on its production and sale, was not able to sell the equipment. The Welding Institute’s available funds were dangerously low and the board went for a new director with a good sales record.

Knud Rimmer came succeeded Larsen in 1980. Rimmer was trained as a welding engineer, and he distinguished from his two predecessors by a combination of a degree as Bachelor of engineering and having extensive management experience, which included sales. He immediately established efficient financial management and he lead the way in international sales activities, essential to sell the excellent P-Scan, which was difficult to sell due to a high price. He also organised the integration of the welding activities at the Technological Institute in København, which implied the establishment of training of welding operators, which had been the main activity at the technological Institute. In the 1980s, he organised departments across the country and in 1990 and 1991 he directed the integration of the Danish Isotope Centre, the Danish Corrosion Centre and Dantest into the Welding Institute’s efficient organisation. New departments were established across the old institutions, but the Welding Institute’s wage system and budget management system were integrating factors and Rimmer accomplished to keep a small staff department. After Dantest’s merger, the overall institute

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34. Minutes, board meeting, 23 October 1974, item 5, board papers, FORCE archives.
35. Minutes, board meeting, 15 November 1979, p.5, board papers, FORCE archives.
was organised as a staff department, seven divisions and two regional department. The staff department included financial and legal administration, technical quality control and a shared project management office. Six of the seven divisions had a technical focus and the last division was training. The two regional department in Esbjerg and Ålborg continues and their activities overlapped with the divisions, which was accepted due to the distances between the regions and the head office near København.

An important component of the shaping of the new institution was a new name. The Welding Institute was the continuing institution, but the organisation’s activities went far beyond welding. In 1991, the was renamed FORCE Institute.36

At the crossroad

After the mergers in 1990, the FORCE Institute was at two simultaneous crossroads. First, the demand for consulting on welding and weld inspection were declining as the gas and oil infrastructure had been completed and due to shipbuilding moving to the Far East.37 This called for restructuring of FORCE’s organisation and the shaping of an organisation that would be able to adapt to future market and technology fluctuations.

Second, FORCE’s international activities had been successful and provided rising revenues and contacts abroad, while the Danish state subsidised technology service system was stagnating. At that time, the work to establish the Single European Market for services had advanced so far that it was possible to distinguish the new opportunities and market conditions in Europe. A key part in the construction of the Single European Market was the establishment of CEN standards for many technological fields, including welding. The Single Market would ease the opportunities for transnational activities in Europe and at the same time it would open the Danish market for foreign competitions, for example from TÜV (Technischer Überwachungsverein) in Germany. In addition the market situation in various European countries would have rising importance for FORCE Institute, as the Single Market would ease FORCE’s possibilities in other EEC countries. Further, the emerging Single European Market

36. Minutes, board meeting 1 October 2990, item, board papers, FORCE archives.
would limit the Danish government’s possibilities to subsidise technological development in Danish companies.

In order to discuss these internal and external issues, the institute’s management held a conference, in November 1990, where they outlined a strategy for the institution, which subsequently was confirmed by the board. The institution’s technological fields were analysed and the attendees at the conference agreed that the basic need was to develop the width and the size of every assignment. Bundles of consultancy and total consultancy needed to be developed and users were to be included into the FORCE’s own development. Further, sales needed to be developed, and they decided to establish a quality control system for administration and management based upon the norms and standards from the Welding Institute.38

Further, they discussed the choice between focussing exclusively on the Danish market or making a substantial international stake, which implied ownership of foreign subsidiaries. Their problem was that the government regulation of the subsidised technological service did not allow the institute to possess shares in companies, and incorporation would probably be needed to establish foreign subsidiaries.39 The government’s reason was ensure that government support for small and medium-sized Danish companies was not used abroad. As the technological service institutes exclusively operated in Denmark, state auditing was simple. Based upon their deliberations, the FORCE Institute decided to have an international stake, but at the same time - if possible - continue their participation in the Danish national technology service programme.

FORCE grows international

FORCE’s first foreign subsidiary was acquired in Turkey in 1992. True, since its establishment, the Welding Institute’s services and products had been based upon information from their international network, and its first foreign assignment was in Norway in 1947.40 How-

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38. “Materiale til strategidøftelse”, report to board meeting 2 October 1990; “Foreløbige resultater af strategikonferencen”, report to board meeting 28 November 1990, minutes to this meeting p.5-6; board papers, FORCE archives.


ever, until 1992 all foreign assignments were managed from Denmark and were based upon sending out people, which curtailed these activities. In the mid 1980s, the institution had considered establishing offices in neighbouring Sweden and Norway, but the idea was abandoned due to unfavourable market conditions and as the institute was not yet ready for substantial foreign investments.

The location of FORCE’s first foreign subsidiary in Turkey was to a large extent a coincidence. In 1992, FORCE bought activities and equipment from the technology service company S&Q Tech in Vejen to enhance its position in Southern Jutland. Within the acquisition, FORCE took over S&Q Tech’s minority block of shares in a technology service company in Turkey.41 Then Danish technological service institutions like FORCE was not allowed to own shares, though FORCE’s stakes in Turkey were small ($50,000). However, the Ministry for Trade and Industry was informed of the acquisition but did not state their objection and, in 1994, they accepted that technology service institutions could own shares. Anyway, The Turkish subsidiary ran into problems in the late 1990s, which caused FORCE to make an additional investment. The Turkish problems proved to have been caused by fraud, and FORCE sold its shares.42

While the Turkish subsidiary was a minor stake, FORCE decided to establish permanent presence in Denmark’s neighbouring states. In 1993, an office was opened in southern Sweden and a subsidiary was established.43 The following year FORCE boosted its Swedish activities through the acquisition of STK Inter test limited.44 To distinguish from the investment in 1992, this implied a significant share holding, which triggered a discussion with the Danish Ministry of Trade and Industries on share ownership. The Ministry faltered and finally, in 1994, it accepted share-ownership.45 In Sweden, FORCE encountered problems


44. STK Inter test, A(ktie) B(olag). Minutes p.9 and attachment “Analyse af STK Inter Test AB”, FORCE board meeting, 21 April 1994; letter, FORCE to Erhvervsfremmestyrelsen, 16 August 1994, attachment to FORCE board meeting 15 August 1994 [SIC!], board papers, FORCE archives.

45. Letter, Erhvervsfremmestyrelsen to FORCE, 10 November 1994, attachment to FORCE Board meeting 28 November 1994, board papers, FORCE archives.
making its activities profitable and they consolidated its activities through additional acquisitions. This gave them a firm position on relevant Swedish market segments for technological service.

In 2002, FORCE went to expand its activities to encompass technological service in neighbouring Finland. They bit for a Finish technological testing company, but it was sold to a Finish company. Subsequently, FORCE bought activities from the Norwegian CorrOcean company, which had departments in the Netherlands, Canada, USA and Brazil. This acquisition gave FORCE extensive international stakes. To control risks, the foreign activities were organised through two completely owned subsidiaries as separate legal entities, FORCE Sweden and FORCE Norway. FORCE Sweden held the activities in Sweden, while FORCE Norway encompassed the activities bought from CorrOcean’s in Norway, the Netherlands, Canada, USA and Brazil.

Implications for the relations to the Ministry and Academy for the Technical Sciences

In the government program on technological service, the technological service institutions provided subsidised consulting to Danish companies - particularly for small and medium sized companies. The state subsidies were awarded as annual grants and grants for specific projects. From the outset, subsidies were awarded as annual grants, but in the 1990s the appropriations became based on detailed yearly programs, which required a growing amount of paperwork.

Within the auditing of state accounts, the use of the subsidies attracted growing interest at the Ministry and they stared to request detailed information about the accounts of the Welding Institution’s and FORCE. However, the subsidies had been advanced since 1973, but the


48 Minutes p.53-55 and attachment, on the decision to acquire activities of CorrOcean, FORCE board meeting 22 April 2003; minutes, FORCE board meeting 27 May 2003, p.60; board papers, FORCE archives.
Ministry only started in 1981 to request information beyond the public annual accounts. Their demands were tightened in 1993, after a leftist government had come to power and as FORCE had started to establish foreign subsidiaries. In 1996, the Ministry requested the auditor’s monthly records, which implied that the Ministry saw these records before the board, which met two or three times a year. This could raise doubt about the board’s powers, and the board protested, but FORCE continued to participate in the subsidised technological service program.49

The ministry’s growing business since 1973 with the Welding Institute and the other research subsidiaries of the Academy of the Technical Sciences weakened the subsidiaries’ need for the Academy umbrella. This need was further weakened, as the Academy’s subsidiaries merged starting in 1990. This produced fewer and greater institutions, like FORCE. In 1983, the Academy mediated a focussed network of its subsidiaries to enhance their off-shore assignments in the North Sea, as these activities here were growing. In the 1986, the Academy suggested to develop this networking further through the establishment of a combine of the Academy and its research subsidiaries. This would boost the several small research institutions with few revenue earning activities, and would be paid by the big institutions, like FORCE. The big institutions rejected the proposal, as should be expected. By 2000, the bigger Academy research institutions had grown to a size, where they only had little need for the Academy’s facilitation. After prolonged discussions, the Academy and its research subsidiaries agreed in 2003 to terminate the formal ties. FORCE and the other former Academy research institutions continued as they were, except that they now had themselves to supply their own board, and the Academy was reduced to be a professional technical-science body.50


50. Minutes, FORCE board meetings, 28 March 2000, p.7; note on FORCE and ATV, attachment to FORCE board meeting 28 September 2000; minutes, FORCE board meetings, 28 November 2002, p.43, 1 December 2003, p.70; letter of intent from ATV, attachment to FORCE board meeting 19 December 2003; board papers, FORCE archives.
FORCE since 1990

Starting in 1991, FORCE strengthened the strategy element in the regular planning of future activities in the divisions. The institution’s planning originated in the 1970s and had started exclusively as projections of existing activities. Now planning was used as a basis to decide which activities FORCE were to aim at, and which activities were to be reduced. Simultaneously the institution’s quality control system was developed, and it became a tool to rationalise staff administration. The institution’s quality control system and its ISO/CEN certification facilitated its foreign assignments. Further, it facilitated the phased construction of an international organisation with subsidiaries in Sweden, Norway, the Netherlands, Russia, USA, Canada and Brazil.

In 1991, FORCE’s management was enhanced through the establishment of a position as deputy managing director. So far there had only been one director. Now, Ernst Tiedemann was promoted to the new position. He is a university trained economist and he had managed the institution’s financial and legal affairs since 1980. In 2000, Tiedemann succeeded Knud Rimmer as managing director. While all his predecessors had been trained engineers, Tiedemann’s accession signalled more emphasis on sales and finance, which was called for by the greater institution and establishment of the Single European Market. Tiedemann used the opportunity to reorganise the company along product lines, while the previous organisation had been a combination of divisions along product lines and cross-divisional departments in Esbjerg and Ålborg and the Swedish subsidiaries, which produced coordination problems between parallel activities in several offices. This organisation had been appropriate for a Danish company until the opening of the rail and road link across the Great Belt in 1998, which significantly reduced the distance between the head office and the offices in Jutland. Simultaneously, the planned establishment of additional subsidiaries abroad called for a more simple organisational form.

As early as 2000, Tiedemann had appointed an engineer as technical director, which established a management with both technical and economic competences, resembling the situation in the preceding period since 1991. Further, Tiedemann enhanced management in 2003. He extended the number of directors from two to four through the appointed of a market director

\[51\] Note, Organisation pr. 1 marts 2002, attachment to FORCE board meeting 28 March 2000, board papers, FORCE archives.
and a financial director. In 2002, the FORCE Institute got the new name FORCE Technology, which held more business connotations than “institute”. Though FORCE was still a private foundation, it appeared in many ways as a company. However, while profit maximization is the objective in an incorporated company, a private foundation only needs sound finances. They do not have to pay dividends, but they need profits to fund research and for consolidation.52

The extended management was also a reflection of the merger with the Danish Maritime Institute (DMI) in 2002, which was due to this institute and its wish to enhance management. The Maritime Institute had revenues of 18% of FORCE’s revenues the year before the merger. DMI was integrated in FORCE’s organisation by establishing a new division for industrial and maritime technology through the merger of DMI and FORCE’s former division for welding and production.53 In 2004 followed merger with DK-teknik’s energy and environment activities.54 Generally speaking, at every merger the management in the appended institution or company were saved, without an equivalent extension of FORCE’s management. In all the mergers, FORCE’s quality control system and its ISO/CEN certifications were essential in facilitating integration of the new Danish and foreign activities.

Between 1990 and 2004, FORCE’s revenues grew from $3,3 million (DKK 30,4 million) to $113 (DKK 699 million) i.e. yearly growth of 29%. However, most growth was derived through mergers, while FORCE had problems gaining organic growth. Since the mid 1990s, FORCE’s sales tended to stagnate and hourly rates grew faster than selling prices. A staff marketing office was established in 2000 to enhance sales of more complex products and services that could justify high hourly rates. The marketing office got the financial resources needed to control the processes of constructing offers with contributions from several divisions, and they also got resources to develop new products across divisions and national borders. Also the staff administration worked to construct transparency between divisions and across national borders. One tool for this end was a database with detailed information of every employee’s qualifications and competences, which was available to all section manag-

52. Interview with Ernst Tiedemann by Lars Heide, 14 February 2005.
53. Minutes p.20-21 and attached note on the merger of FORCE and DMI, FORCE board meeting 19 April 2002, board papers, FORCE archives.
54. Minutes, FORCE board meetings, 28 August 2003, p.64, 19 December 2003, p.73-77; note on this takeover attachment to board meeting 19 December 2003, board papers, FORCE archives.
ers. However, it was not a simple matter to devise and establish projects stretching across sections, divisions and countries.

Reflections

FORCE Technology’s history exemplifies two important issues in current technological development: The role of government and the balance in engineering between management and engineers.

In the late 1960s, industrial growth faltered and governments in Western countries rushed for support, as they previously had engaged in agriculture. The Danish government established a technological service system in 1973, which FORCE has been engaged in since. Nearly twenty years later, FORCE discussed the consequences of the limited size of the government-sponsored scheme and its incompatibility with foreign business. True in 1990 the government-sponsored scheme provided 32% of FORCE’s revenues, but the amount appropriated for the scheme was planned by the government to decrease significantly in the following years. To compare FORCE’s foreign business only provided about 20% of the total revenues. However, and the Single European Market would ease business and competition across borders as there was growing trade in technology services beyond Europe. In 1990 FORCE chose an international strategy which constituted a negative assessment of the importance of direct Danish government support for technological development in industry.

The second set of reflections relate to the change in the balance between management and engineers and the impact of this change on products and services offered. The varying training of the (managing) directors is a simple entry to this issue. While the first and the second director were masters of engineering, the board of directors chose a bachelor of engineering with extensive management and sales experiences as the third director, and the present managing director was trained as an economist. This line points to shift from an engineering focus to a management centred approach, which was related to the changed composition of the board of directors. This was chaired by professors at the Technical University of Denmark until 1977, when they were succeeded by a succession of managing directors from industry. FORCE’s management changed focus from a narrow technology focus, which also focussed the employees, to a broader focus also encompassing customers, markets and finances. How-
ever, this observation should be cautioned by the fact that all the eight current division leaders are trained engineers.

This turns focus to the impact of the observed change upon products and services offered by FORCE. The ultrasound based P-Scan was developed within the Welding Institute’s strategy in the 1970s that focussed on high-profile scientific engineering. P-Scan had world-class excellency and remains an important asset between FORCE’s products and services. However the costs of its development nearly toppled the institution, which called for a stronger management that focussed more on finances. Since, the new management accomplished to make the institution thrive. The employees produce excellent technology-based services in growing scale, but they seem not to have produced a second world-class technological device.

FORCE’s current work to develop a method to attain germ-reduction exemplifies the management’s endeavour to design and apply products across old divisions. The germ-reduction method is based upon a combination of steam and ultrasound, which is an old competence at FORCE. FORCE bought the germ reduction idea in 2000. It is being developed in cooperation with a Danish poultry slaughterhouse, which will use it to combat campylobacter and salmonella germs in their poultry. This technology should not leave any trace of its application on the poultry, it only applies water - which anyway is used - and it has a wide variety of applications from non-toxic treatment of seed grain with fungicide to cleaning in industry. This germ reduction method is smart and it may earn large revenues, but it is not based on the same kind of sophisticated technology science development as shaped P-Scan.

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55. Interview with Ernst Tiedemann by Lars Heide, 14 February 2005.