

Slow growth and revolutionary change. The Norwegian IT industry enters the global age, 1970-2005

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Abstract

The article concludes that although the Norwegian IT industry has been lacking in export success the last 30 years, it has been important for the development of the Norwegian economy. Several IT companies have been on the verge of international breakthroughs, but have been stopped by rising costs and guided by national opportunities. The rise of the important oil-sector has been both a hindrance and an opportunity for the Norwegian IT industry. Specialised products for national markets rather than general mass-market products have become the norm for the Norwegian IT industry. This development had to a remarkable degree been associated with continuity in terms of organisations and people. The firms these people and organisations have been attached too, however, have experienced turbulence, bankruptcy and change, making the whole development from 1970 until today a seemingly messy and problematic affair. But this has really been a period of IT industry growth, and in the end the national development is reasonably successful.

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Introduction

Although Norway is one of the world's richest nations and consequently a large user of IT equipment and IT solutions, it remains a relatively small producer of IT equipment.¹ Of the four, rich Nordic nations, Norway has the smallest production of IT goods, both in terms of absolute value and in terms of the IT production as percentage of total industrial output.² Norwegian imports of IT goods have at the start of this century for some years constituted about three times the value of Norwegian IT exports. In terms of quantitative significance of what may be termed "national IT competence", Norway is the Nordic jumbo. This chapter sets out to shed light on how the Norwegian IT industry has developed and why Norway has become such a comparatively poor IT performer.

It is not because of a late start. Norway was an early starter in what became the IT industry.³ Already in 1882 a Norwegian maker of telecommunications equipment was started, Elektrisk Bureau, based on the very early and intense use of telephone in Norway. Elektrisk Bureau also soon had exports and foreign operations at the turn of the last century.⁴ Prior to World War II several new electronic companies were started, mostly making different kinds of radios, and gradually a fully-fledged industry formed and developed, to a substantial degree in relationship with Government policies promoting IT production. Both Tandbergs Radiofabrikk and Norsk Data were at times quite successful in foreign markets, and especially Tandberg was well known. But the success disappeared as time went on, and for the time being Norway is the worst Nordic performer.

The staggering difference in 2007 between Norway and its Nordic neighbours Sweden and Finland is the absence of any large multinational company in the IT sector. Sweden's Ericsson and Finland's Nokia are not matched by any comparable Norwegian enterprise, and even fellow Nordic IT laggard Denmark has world-famous consumer electronics company Bang & Olufsen to its name. Why is Norway not more successful? Could it be because of lack of competence? Probably not, but more will be said about that later. There is an argument for the cost-increasing and crowding out effect of the large oil and gas sector in the Norwegian economy since the mid 1970s that has made it difficult for Norwegian export-conscious IT companies to grow profitably abroad, and this important argument will be extensively discussed below.⁵ But let it already be said here that since Norway is not the only Nordic exception to industrial success, there might be something to be learned from oil-free Denmark – a rich, small nation with a large IT sector and a comparatively small own production. Clearly Denmark and Norway have used IT in various ways and profited from this, the results of which may be found in general economic growth figures and not so much in IT industry statistics.

The focus in this discussion will be on the IT *industry*, i.e. the industrial and research-based part of the IT sector, arguably the best way to gain insight into the Norwegian national IT competence and its competitiveness. The following chapter is divided into five parts. First, the current situation is discussed, leading to a discussion of the historic development of the Norwegian IT industry, with emphasis on understanding the situation at the beginning of the 1970s. Then the development during the troubled 1970s and 1980s is discussed in two parts, before the ensuing changes of the IT industry are analysed. Finally, at the end, there will be a discussion of the long-term implications of this.

Large user, small producer (1970-2005)

The four Nordic countries are very similar in terms of population, economic structure and history. Sweden, with around nine million inhabitants, is roughly twice as large as each of the other three nations, and Finland – with its later start as an independent nation and its different language – is the odd nation out. But by and large the four are quite equal, and among these one *has* to be the worst IT performer in terms of industrial performance. That place belongs to Norway.

The gross turnover in the ICT sector of these four nations is remarkably similar, as is underlined by Table 1 below where absolute turnover is corrected by population size. While Norway has the smallest turnover in absolute terms, Norway is also the least populated nation of the four, and the small differences between Norway and Denmark and Finland may be explained by those differences. Sweden, with a global player in telecommunications along with a thriving Internet business up until 2000, was the biggest of the four. Finland was industrialized later than the other three nations, and the table more than underlines that Finland has caught up and is well able to compete.

[TABLE 1 ABOUT HERE]

Sweden and Finland have more people employed in the IT sector than Norway and Denmark. Although the number of people employed in Norway is a significant one with around 80 000 employed in 2001-3, this is by far the smallest number of the four nations. Finland and Sweden, with their huge Nokia- and Ericsson- successes respectively, have the largest number of

employees in terms of population, also when correcting for population size. Sweden may have been hit the hardest by the dot.com-crises, i.e. the special crisis in the Internet business that was integral to the general stock-market crisis in 2000. Sweden's entrepreneurial effort in the Internet business was huge in the late 1990s, and the fall was consequently high. The national flagship, Ericsson, also restructured in the period after 2000 and a number of employees lost their jobs.

By and large Table 1 underlines the importance of ICT in the four Nordic countries. *World Economic Forum*, the business meeting held in Davos, Switzerland, along with the Swiss business school Insead, do a yearly ranking of global ICT capabilities, "The Networked Readiness Index", and here the four Nordic countries do extremely well.⁶ Denmark was on top of the 2007 rankings, with Sweden (second), Finland (fourth) and Norway (tenth) among the ten top achievers. The high general use of ICT also corresponds with a large ICT service-sector in all four countries, along with efforts in production of goods and programming tools.

It would be of great interest to see what the impact of ICT services on the Norwegian economy has been. Use of ICT – broadly defined – started early and had great impact in a number of businesses, not least insurance and banking.⁷ The Bull name in Honeywell-Bull came from the Norwegian Fredrik Rosing Bull who started out making tabulator-machines for the Norwegian insurance company Storebrand in the late 1910s and before he went to France. More recently retailing and other services have made a great use of ICT, possibly with great effects, though the real economic impact of ICT is debated.⁸ That whole – huge – sector of service providers, software houses, and ICT departments in large companies of various sorts, is beyond the scope

of this article. The statistics do not easily tell the story of what is happening around the service providers, but there is no denying the huge activity – 45,7 billion Norwegian kroner in 2004.⁹

Norway has gained a software sector of some importance, though it is difficult to define the extent of this sector. Most of the people doing research in Kongsberg Gruppen, the largest Norwegian ICT enterprise, are in some way doing programming.¹⁰ Most of the people in “the software sector” – elsewhere – are doing some kind of service that is very remotely connected to the making of standardized IT goods, which is what Kongsberg Gruppen makes. There are very few Norwegian makers of standardized software that are competitive internationally, but the most renowned are the Internet-browser Opera, the data-search maker Fast and the developer of programming language Trolltech. Trolltech develops programming language in an incidental continuation of the 1960s Norwegian international success, Simula. Simula was a language introducing so-called modularity and has been used extensively for regulatory purposes.¹¹ The two men behind the language were professors at the University of Oslo, and one of them had his background at the National Defence Research Establishment. Simula never became a commercial success, but was a technical breakthrough for a way of programming. It underlines ambitions and competence in the Norwegian IT sector, present for several decades. It also makes the question of why Norway has not achieved more export success very relevant.

The remarkable differences between the Nordic countries come through when their indigenous ICT production is compared. Table 2 – made up by “Audio and Video equipment”, “Computers etc.”, “Components”, “Telecommunications” and “Other”, and with consultancy and software left out – gives the broad picture of national production. In terms of numerical values the Nordic

countries contains two clear leaders, Finland and Sweden, and two laggards, Denmark and Norway. Further reading of the underlying statistics uncovers the result of two telecommunication companies' huge global success, namely that of Finland's Nokia and Sweden's Ericsson. Stripped by the success of their huge production of telecommunications, the numbers of Finland and Sweden are not that impressive compared to Norway and Denmark. Yet these companies' huge success must to some degree reflect their national roots and the task to be explained on Norway's part may therefore to a large degree be why there are no large Norwegian IT companies.

[TABLE 2 ABOUT HERE]

Denmark comes across through these numbers as not up to Sweden and Finland's standard, but that should be seen against the background of Denmark's commercial success being larger than these numbers imply. While the numerical value of Norwegian exports of ICT goods is almost equal to that of ICT production, the Danish exports are almost twice the size of its production.¹² That difference may be accounted for by re-exports and export-sales of software and services.

Table 2 also shows how the rise of Finland is such a remarkable phenomenon. The 1973 numbers for the "electronics industry", which in most respects is the same as the IT industry, show Finland to have been the clear Nordic jumbo in 1973. It only goes to show how remarkable the rise of Nokia has been. Yet Sweden, too, being the most successful in 1973, is a great growth success in the ensuing years, and that must also to a large degree be because of its large manufacturer of telecommunications. Indeed, the numbers for 1973 comes from a 1976 official

Norwegian investigation into the future of the electronics industry, and here the importance of Ericsson for Sweden was remarked upon already then.¹³

Much of the 1970s policy discussion on the future of the Norwegian IT industry revolved around how to create successful exporters. This was hardly an unqualified success. Yet the numbers in Table 2 also reveal that the period from 1973 until the present has been one of growth, and that the performance of Denmark is not that different from Norway's. Since this is also the period of industrial transformation from "electronics" to IT – in large part from analog to digital technology – the overall growth for such rich and research orientated countries could have been expected to be higher. Finland and Sweden were global innovators in telecommunications in the period, while Norway and Denmark remained fairly small makers of IT.

The closer look at the Norwegian experience over the period from the early 1970s reveal – as seen in figure 1 – a rather steady development over long periods of time, with rather sudden and short-term variations. That development will be expanded upon below, but here a few words should be said about these numbers. The figure is based on two slightly different classification systems. The numbers from 1972 to 1992 are based on the ISIC-classification, while the numbers from 1992 to 2005 are made according to the NACE-definitions.¹⁴ Quite possibly the earlier numbers overestimate the size of the IT industry in the period 1972-1992, as is indicated when numbers from the same years are compared (see 1992 in the figure). The number for employees is 12 % higher in 1989 according to ISIC-numbers than according to NACE-numbers, and the number of employees given for the year 1973 in the above-mentioned investigation of 1976 is 17 % lower than in figure 1. But by and large the numbers from the two classifications fit relatively

well, and they tell a story of an industry that from the years since 1972 have doubled in size of production, employs almost the same number of people, and whose sustainable growth – if such a term can be used – has come since the early and mid-1990s.

[FIGURE 1 ABOUT HERE]

The Norwegian growth came, however, without large and visible companies. The difference between Norway and Finland and Sweden may be sought in the question of why Norway has not fostered a large IT company, and in the following the Norwegian development will be analysed from a company perspective. Why did the Norwegian pretenders of the 1970s and 1980s not succeed? Is there to be found a common reason behind these failures? After all, the development of Norway – slow growth and revolutionary change – is not so bad. Yet at the start of this period – let us say in 1973 – the situation may even have looked quite promising, and certainly Norway was ahead of Finland.

An industry set to grow? (1900-1973)

The best explanation for Norway not to have a success like Nokia or Ericsson may be the presence of Nokia and Ericsson. There simply was not room for a Norwegian version of this Nordic path to international success. But the question of why there was no Norwegian Nokia is a better one than the superficiality such a question normally entails. If there was one area where Norway had broad and deep competence, it concerned mobile telecommunications.

Norway was an early starter. The aforementioned Elektrisk Bureau was fairly successful until the crisis in the 1920s when Swedish L.M. Ericsson bought a controlling share in the crisis-ridden Norwegian competitor. In the early 1930s, in the reorganisation in the aftermath of Swedish entrepreneur Ivar Kreuger's death, another foreign-owned Norwegian telecommunications company, STK (Standard Telefon og Kabel) was created by ITT on the basis of an import company and a Norwegian cable-maker.¹⁵ L.M. Ericsson-controlled Elektrisk Bureau and ITT-controlled STK became from the early 1930s and up to 1990 the providers of telecommunications to the Norwegian telecom operator, Televerket. Both of them had Norwegian minority shareholders, both of them had large production in Norway, both of them had some Norwegian research activity, and they were – in the early 1970s – two of the five largest Norwegian electronics companies in terms of turnover and employment with well over 1000 employees each. They were also controlled by an oligopolistic grip by the international operators L.M. Ericsson and ITT. So Norway had a telecommunications industry, albeit one controlled from abroad.

Norway's strongest national asset may have been its broad competence in radio communications. While Norway may have been a typical industrial country with strong interest in radio receivers that became the foundation of the modern consumer electronics industry, Norway had large merchant- and fishing-fleets purchasing communication equipment since the 1910s. In the interwar years this demand was met by an array of research-intensive small operations – Elektrisk Bureau, STK, the Norwegian Marconi-company, the Norwegian Telefunken-company and some wholly Norwegian companies – making radio equipment.¹⁶ While World War II and ensuing developments to some extent changed the fortunes of this industrial segment, it was

important until the 1970s when the process of introducing satellite-communication began.

Norway have had a strong national and Government-funded commitment to space research for meteorological and telecommunication purposes,¹⁷ and the company Nera – a wholly Norwegian continuation of Norwegian Telefunken – became the main Norwegian operator in satellite-telephony, being the heir to the old maritime radio industry.

Equally important was the change in Nera's fortunes just after World War II and its inclusion into national policy. Through allied wartime research, Norwegian engineers had been involved in large radar projects.¹⁸ When this competence was continued within the 1946 creation NDRE (National Defence Research Establishment), collaboration with Nera was soon established. The knowledge from military radar projects was transformed to military and civilian radio-link technology, radio-links being wireless radio-transmission of telecommunications and an alternative to cable not least in a mountain-rich country like Norway.¹⁹ Nera became a medium sized Norwegian company with several hundred employees, depending on Norwegian and NATO markets for civilian and military products, as well as the odd project for developing nations.

Nera – along with Simrad – was perhaps the one company up until the 1970s that was shaped the most by Government R & D funding. A host of new organizations were started after the war, creating a new public research infrastructure of Norway. The new organizations included the aforementioned NDRE and Simrad, as well as two national research councils and two important research establishments for the technical research council and the Norwegian Technical University respectively. While Nera was linked to the effects of allied research in radar, Simrad

was influenced by allied research in telecommunications and hydro-acoustics. The founder of Simrad, Willy Simonsen, coming from a business family and being a leader in British walkie talkie construction during the war, established a company selling radiotelephones to the large Norwegian fishing-fleet. He was himself involved in technical issues for the company in the beginning, not least when Simrad shaped naval echosounders and sonar-equipment licenced from NDRE into small and efficient fish-finding equipment sold increasingly globally.

Simrad's founder Willy Simonsen was a transitory figure in Norway, bridging the gap between the prewar entrepreneurial community of founders of electronics companies based on competence gleaned from an education abroad (in Simonsen's case, Dresden) or in Norway, and the postwar industrial effort that to a much larger degree involved public research institutions. The prewar entrepreneurial effort created a Norwegian radio industry selling receivers for the national broadcasts. Up until the early 1950s, and the postwar crisis of the Norwegian radio industry, there were tens of makers. Some of these were established by amateurs with little education, and others, like Vebjørn Tandberg, were well-educated engineers with contacts in the few prewar research institutions, but were, when all was said and done, independent industrialists. Vebjørn Tandberg with his Tandbergs Radiofabrikk and his brand "Tandberg" was hugely successful, and in 1972, through the merger with long-time competitor Radionette, Tandberg was in all respects the last of these radio makers.²⁰ In 1972 Tandberg was among the three largest electronics makers in Norway, with a healthy export of tape recorders and stereo equipment and a growth-policy in colour televisions and a research program in computers. Tandberg was a small "Philips" – the Dutch giant – and a source of national pride.

The last of the main Norwegian companies of the period that must be mentioned is Kongsberg Våpenfabrikk, the state owned weapons-manufacturer that since the late 1950s had been upgraded to become a maker of advanced rockets and command and control systems as well as other products for various automation purposes.²¹ Kongsberg Våpenfabrikk worked in tandem with some of the above-mentioned public research institutions, but the main provider of new products was the NDRE, an increasingly independent promoter of new technology on the Norwegian research policy scene.²² Kongsberg Våpenfabrikk was involved in a host of new technological activities reaching beyond IT, but there was a strong digital technological approach leading to signal-processing and systems technologies.²³ Kongsberg Våpenfabrikk also made mini computers beginning around 1970, and the computer technology was also received from the NDRE.

NDRE and the other research-institutions had an increasingly important role for the Norwegian IT industry. NDRE is particularly known for its role in the modernisation of Kongsberg Våpenfabrikk, its relationship with Simrad and the fact that several of its engineers in the late 1960s broke out and established the mini computer maker Norsk Data. Norsk Data was a very early starter in this industry, and had by the early 1970s established itself technologically and internationally, even though it was at the time a very small company. Just how important and what the general influence of the government's research institutions were in all places and at all times has not really been investigated by historians. Elektrisk Bureau, STK and Tandberg were quite large and until the mid-1960s, their research was quite independent of the public effort and funded from company sources. The two telecommunications companies also had international partners. In hindsight, the influence of the public research institutions is easily overstated by

comparison with the R&D efforts of the larger industrial enterprises, at least up to the end of the 1960s. In addition to Norsk Data, the most important new company was AME (A/S Mikro-Elektronikk and originally called Akers Electronics), a maker of integrated circuits established in 1965 as a spin-off of the technical research council's research establishment.²⁴

The influence of the Norwegian research-institutions gained in importance, and when the national telecommunications provider, Televerket (Telenor since 1994) started its own research institute in 1967, both Elektrisk Bureau and STK felt compelled to start their own formal research laboratories to collaborate with Televerket.²⁵ Televerket's R&D Institute wanted, among other things, to help Nera to become a satellite communications company, and to help Elektrisk Bureau and STK to become more independent of their mother companies and possibly gaining a role of lead houses within their respective multinational corporation.²⁶

Overall, the development of the Norwegian IT industry until 1973 may be described as an amalgamation between private enterprise and public research policy, with public research policy playing an increasingly important role.²⁷ Up until around 1960 and the impact of the debate on economic growth, the Norwegian IT policy rested on *research* policy. The industrial policy of Norway – which since 1945 had been quite interventionist – did not really concern the electronics industry. However, due to a number of developments, not least the discovery of the “residual” and the impact of technology on economic growth, electronics suddenly had center stage of industrial policy.²⁸ The modernisation of state owned Kongsberg Våpenfabrikk, and the start of AME, as well as Governmental finance for development projects done by Norsk Data, Simrad and other companies were part of this policy change.

The Ministry of Industry had little directly to do with these changes, as the new industrial policies of the 1960s were delegated to three or four government-appointed organizations for financing various worthy causes. The overall strategy constituted a kind of “indicative planning” with the government funding indicated priorities like development activities, export collaboration, mergers and locational issues. With the coming of the 1970s the Ministry of Industry became increasingly involved as the need for continued growth was deemed important, and the possibilities for such growth were seen – by several political parties, but especially the Labour party – to be found in increased collaboration between companies, the Government and various public organizations. In 1973 the Government proposed a national investigation of the electronics industry, a testament to the priorities of the time, and a sign of challenging developments.²⁹

Revolutionary change, part I

In retrospect, there is every reason to applaud much of what went into what might be called “a national plan” for electronics in the 1970s: Norway had a concerted effort in new digital technology, through new companies, research organizations and the modernization process of older companies like Kongsberg Våpenfabrikk. Several companies, in addition to Tandbergs Radiofabrikk and Simrad, Kongsberg Våpenfabrikk must be mentioned along with Nera, had some export success. Yet when all is summed up from 1990 as a vantage point, almost everything was in ruins. None of the main Norwegian companies existed in the same form as they had entered the 1970s, and in no instance could that development be counted as something remotely positive.

What happened was the combined result of several factors, but the difference between Norway and all other industrial nations was the complex and dramatic effects of the domestic oil and gas industry on the Norwegian economy. One crucial consequence of the oil and gas was to increase the cost structure of the whole economy, the IT exporters included. But this is only a partial reason for the IT industry's development, and other factors also made their mark. The 1970s differed from the 1980s. The companies most severely affected by the 1970s were Tandbergs Radiofabrikk, Simrad and Nera as well as a host of smaller companies, while Elektrisk Bureau, STK, Norsk Data and Kongsberg Våpenfabrikk were severely hit by the developments of the 1980s.

The actual effect of the oil in the Norwegian economy of the 1970s was indirect.³⁰ Policymakers' expectations of large oil revenues were instrumental in the strong counter-cyclical Keynesian economic policy applied during the downturn following the OPEC oil price increases of 1973. The situation for a new oil producer like Norway was contradictory of course, for the very price shocks that negatively affected the world economy had a positive effect on the new oil sector of the Norwegian economy. The pressure in the Norwegian economy in the years 1975-78 came from a collection of state budget deficits, helping packages for export industry in trouble, as well as the rapid rise of a new sector being built to extract and process the oil that was increasingly coming into production. The effects of this new environment on IT companies like Tandberg were complex: On the one hand they could find Governmental support for nearly every constructive effort to restructure, but on the other hand those "gifts" were part of a broader economic transformation that drove costs up to an increasingly painful level. Tandberg started to lose money and ended as a fully state owned company in 1978 when the problems progressed to

a level it could not deal with. Yet almost at the same time that the state fully took over, the Minister of Industry realized Tandberg could not be saved and the company went bankrupt in December 1978.

Tandberg's problems were, of course, not solely related to its Norwegian location. Competitive and technological changes deeply affected the company's situation. In the aftermath of the bankruptcy there was not difficult to name a number of factors that undermined Tandberg's situation. But these factors also affected most of the European consumer electronics industry at the time and some companies survived, like the Danish firm Bang & Olufsen. The avenue followed by Bang & Olufsen in its successful restructuring, which emphasized exterior design, increased reliance on purchased technology and large reorganization and sackings – was not taken by Tandberg, for a complex number of reasons.³¹ First, Tandberg was very conscious about design, and while Bang & Olufsen chose a minimalist modern design there is a certain techno-Scandinavian flair (metal and polished wood) connected to Tandberg's products that had large appeal. There is no evidence that Tandberg's products had any design disadvantages, and Tandberg's sales slightly exceeded those of Bang & Olufsen until the early 1970s. Prior to Bang & Olufsen's large reorganization in 1974/75, Tandberg had much higher turnover per employee than Bang & Olufsen, evidence of better organization of production and a hint that Tandberg's last "pre crisis" CEO, Andreas Skogvold, was onto something when he – after the bankruptcy – claimed that Tandberg in early 1977 was better at the technical aspects of automation of colour television production than the Japanese.³² Skogvold was an expert on automation and had visited several Japanese plants. But Skogvold also argued that the Japanese worked harder and were more disciplined than the Tandberg employees.

And here was the problem: Tandberg was a model enterprise, famous for its remarkable industrial relations, which had been conscientiously nurtured since the 1940s by founder and CEO until 1974, Vebjørn Tandberg. Sackings and downsizing were out of the question, and ever since the company had introduced new products like the tape recorder in the early 1950s, new products were seen as both replacements for products with saturated markets and tools for growth. In the 1970s Tandberg was to grow with colour televisions (Tandberg was the second foreign firm to produce colour televisions in Great Britain in the 1970s, after Sony).³³ In the 1980s, when Tandberg perceived the colour television market to be saturated, Tandberg was to grow with new computer products, streamers (based on Tandberg's tape recorder technology) and monitors (from television). So the outstretched Governmental hand, attached to a growth-oriented policy that built on the above-mentioned national investigation of electronics, supported Tandberg's efforts to develop new products to support growth. The Ministry of Industry even made a plan in 1976 to concentrate the national R&D efforts around three cornerstone enterprises that were to operate in the middle of the electronics industry: Tandberg in consumer electronics, state owned Kongsberg Våpenfabrikk in defence electronics and a partly nationalized Elektrisk Bureau in telecommunications.³⁴ When the decisions about Tandberg's future were made in early 1976, and the company was in such trouble that it had to harshly restructure and sack employees to continue as an independent company, the Government's willingness to help won the day. CEO Andreas Skogvold's plan to cut costs and reorganize was overruled by the board of directors, a decision supported by Vebjørn Tandberg (member of the board), the Government and the labour unions, all of whom agreed that Tandberg should slug it out and hope for better days, financed by the Government. From then on everything went to pieces.

Could Tandberg have survived? Bang & Olufsen did. Some of Tandberg's business continues until this day and is mainly represented by the computer products organized in two stock-listed companies. The high end stereo business have several, small companies as survivors, but the products aimed at large quality mass markets where Tandberg was famous in Norway and abroad was discontinued, as was the colour television production. Survival for Tandberg would have required many changes and adaptations, not least the ability to deal with abrupt sackings and what would have entailed a radical shift in the organizational culture. But in terms of market position, R & D-capabilities and the technical knowledge about automated production, Tandberg had a decent platform with which to try. But the political support and financing for continued reliance on past strategies in a new globally competitive market meant that the firm never pursued such a radical (and risky) strategy and Norway's single most important electronics company went bankrupt.

Two of Tandberg's problems – the economic pressure in the Norwegian economy and the technological shift – affected most of Norway's IT companies. Perhaps Kongsberg Våpenfabrikk, which had had a digital IT strategy since 1960, was the least affected as it did not have any old electronics products in its portfolio, and the 1976 cornerstone plan made much more sense for this defence-centred company than it did for Tandberg. Kongsberg Våpenfabrikk purchased a couple of troubled Norwegian electronics companies and was given new equity to do so by its owner, the state. Particularly noteworthy among these takeovers was Kongsberg's acquisition of Norcontrol – a ship automation company founded in 1965.³⁵

Elektrisk Bureau, the large maker of telecom equipment, also experienced rapidly changing technology and was able to shed parts of the workforce as production became more automated.³⁶ The 1976 cornerstone plan had great promise for Elektrisk Bureau, not least in relation to the large programs for modernizing the national and Nordic telecom infrastructure that were underway. Telecommunications was perhaps the most constructive part of the cornerstone-plan, and around a quarter of Elektrisk Bureau's shares were bought by Norwegian investors from L. M. Ericsson, which reduced the Swedish company's share by a half. This was the result of negotiations between the Norwegian Government and the Wallenberg family, large owners of L.M. Ericsson. Elektrisk Bureau also took over Nera, a company experiencing a multitude of problems in the 1970s. For Elektrisk Bureau and STK, the situation in the 1970s was characterized by a close relationship with the authorities, not least the Ministry of transport. This gave the companies a certain planning horizon when production was being reorganized. The cornerstone-plan seemingly enhanced this situation, linking the traditional relations between the telecom sector and the Ministry of Transport more closely with national industrial policy and the Ministry of Industry.

Simrad, like Tandberg, was challenged by Japanese competition.³⁷ Simrad, a producer of small hydro-acoustic equipment to fit all kinds of vessels everywhere, was a global innovator in a small niche. Traditionally its main competitors had been the likes of British Kelvin Hughes and German Atlas – with their naval roots – but the 1960s meant the arrival in international markets of a host of Japanese competitors like Furuno. Simrad met this competition in much the same way as Tandberg, through developing more advanced products and finding new products.

Slugging its way throughout the 1970s, Simrad experienced a situation that by 1980 resembled what Tandberg experienced in 1976 – falling sales and falling prices.

Unlike Tandberg, Simrad responded with rationalization, reorganization, outsourcing of production, and splitting the company into several smaller units. The unit providing deep-water hydro-acoustic position equipment for the growing oil business became a huge success and was listed on the Oslo Stock-exchange in 1982. The unit making fishing equipment went into a deep crisis that was only solved when young engineers with some years experience from the NDRE was recruited and they radically redesigned Simrad's sonar-equipment to take full advantage of the digital technology that they – unlike Simrad's older engineers – had mastered. Building on that new technical platform, and the earnings from the oil-directed company that purchased the fishing business when it mastered the new technology, Simrad was a very successful company throughout the 1980s. The new national oil market became increasingly more important.

There were several differences between Simrad and Tandberg, not least in terms of political climate. Simrad's troubles emerged after Tandberg's problems had sent shockwaves through the Norwegian political system. Tandberg's bankruptcy in late 1978 – the same year that the state formally became sole owner – reflected the radical policy-shift taking place in Norwegian industrial policy, with the Tandberg-case being the most blatant example of policy mismanagement that for a time led to a very difficult Parliamentary situation for Labour in Government. 1978 was also the last year of general counter-cyclical economic measures, partly for some of the same reasons and the loss of competitiveness for Norwegian industry during the

late 1970s. It was out of the question in 1980 to help Simrad, even if Simrad's politically conservative owner would have accepted it.

To what extent had the "system" of productive interaction changed for the Norwegian IT industry during the 1970s? In one respect, the coming of activist policies of the 1960s had progressed into a very interventionist stance in the mid-1970s that was gone by 1978. The growing interdependencies between research institutions and the Governmental infrastructure of industrial finance was still in place, but the two companies formed in the 1960s to play important roles for the whole electronics industry – AME (integrated circuits) and Norsk Data (minicomputers) – functioned more or less as independent companies and did not play important roles in significant national networks. The most internationalized companies, Tandberg and Simrad, were hit hard by the new global competition and Tandberg ceased to exist, as did its mass market products. Simrad changed a great deal, from a family owned mass market operator to a stock-listed company selling complex technology for much higher prices.

Two new changes were underway at the end of the 1970s, however, that were profound new developments to the whole after-war period. The first was Governmental promotion of the stock exchange as an *alternative* to industrial policy and state controlled funding, something which underlined the change of atmosphere and, of course, reflected liberal attitudes found in several western countries at the time, not least Great Britain and USA. The second change followed in the same ideological path, namely a gradual shift to a new purchasing policy on the part of the state. The Norwegian public sector was never a totally nationalistic purchaser of goods, reflecting strong liberal values.³⁸ But the 1980s certainly changed the tide to a liberal inclination.

Revolutionary change, part II

While the 1970s had ended on a negative wave for the electronics industry, the first half of the 1980s started with a bang. This proved to be the decade of the entrepreneurial IT firm, often listed on the stock exchange, and Simrad and Norsk Data were preminent actors on this new stage. But the decade was ruinous to the larger Norwegian corporations, and when the 1990s came, Elektrisk Bureau, Norsk Data and Kongsberg Våpenfabrikk – along with several new start-ups – were gone, and STK was a shadow of its former self, doomed to fail later in the decade.

In retrospect the failures of the 1980s were a result of the deregulation wave, in addition to the continued technological revolution. The first casualty was Elektrisk Bureau. After fifty years as co provider for the Norwegian telecom monopoly, as one part of a politically influenced duopoly with STK being the other company, the “contract of the century”, the first fully digital switch for the Norwegian telecom infrastructure, was to be provided by one company through an international tender.³⁹ Elektrisk Bureau – partly nationalized in 1976-77 through the Government’s cornerstone-plan – was everybody’s favourite to win with L.M. Ericsson’s AXE-system. But the contract went to STK, which promoted ITT’s still-incomplete “System 12”. Elektrisk Bureau was weak and ended up being merged into a Norwegian maker of electrical equipment, something that Elektrisk Bureau also made. When the great merger between Swedish ASEA and Swiss Brown Boveri happened in 1987, Elektrisk Bureau – through L.M.Ericsson’s 25 % ownership, and the Wallenberg-family’s strong position in both ASEA and Ericsson – became part of ABB Norway. The telecom business that once had dominated Elektrisk Bureau became a minor part of ABB Norway.

STK did not fare much better.⁴⁰ Winning the 1983 contract turned out to be something of a Pyrrhic victory. Getting “System 12” operational was a huge undertaking and a strain on the relations between STK and majority-owner ITT. Even though “System 12” was a product of ITT, STK had to bear a lot of the cost. When in 1986 “System 12” actually functioned – a fully digitalized, modern switch – the benefactor was ITT, or more precisely ITT’s owners who were able to get a good price for the firm’s telecom operations in a sale to French Alcatel. STK was renamed Alcatel Norway and this turned out to be the beginning of the end for what had until then been a semi independent company with a sure Norwegian market. STK/Alcatel was not helped when the next big contract for Norwegian switches in 1990 went to Ericsson Norway, the telecom-remainder of Elektrisk Bureau that subsequently had been sold to Ericsson. From then on Alcatel Norway was reduced to little more than a sales organization for the large French multinational.

On one level the rapid creation of two new multinationals in the same year – 1987 – affecting the duopoly of Norwegian telecom producer might be seen as coincidental. And if such a sign of increased globalisation was not coincidental, the role of Norway hardly mattered. According to Sverre Christensen’s recent doctoral thesis about STK it certainly did, as Norway was one of the countries most open to international competition and modernization of its telecom network.⁴¹ Getting the Norwegian contract – the first fully digital switch – was getting ahead of the competition and may to some extent have affected international telecom strategies. But the changed attitude of the Norwegian Government to purchasing telecom equipment certainly must have changed private investors’ attitudes towards participating in this industry. Although both STK/Alcatel and Elektrisk Bureau/Ericsson Norway were foreign-owned, they had had a

significant Norwegian component within them. Several new companies have been created in the aftermath of the dismantling of Elektrisk Bureau and STK, the most significant of which was Nera, listed on the stock exchange in 1994 after seventeen years in the Elektrisk Bureau/ABB fold. More than anything, however, the attitude of the Norwegian Government shed light on why there was no Norwegian contender in the commercialization of the next great innovation in telecommunications, GSM.

Mobile telephony – with its use of radiowaves – was “natural” for Norway, that is to say the Norwegian nature and topography with high mountains and lots of sea had made its mark on Norwegian telecommunications competence.⁴² In addition to maritime radios, satellite-communication and radio links, the Norwegian Defence had been particularly concerned with radio communication.⁴³ Televerket’s R&D Institute was also very active. Both Elektrisk Bureau and STK had been active in these fields based on their respective Norwegian competence, Elektrisk Bureau being in particular an expert on radio communication while STK made military switches.⁴⁴ Up until the early 1990s Norway also had a maker of mobile telephones, Simonsen Elektro, the company that Simrad-founder Willy Simonsen started when he left his original company in 1967. Simonsen Elektro was the Norwegian counterpart to Ericsson and Nokia in the system developed by the Nordic telecom providers called NMT. In the latter part of the 1980s, when the international community had chosen the wireless technology originally developed by a *Norwegian* scientist as its GSM-system, Simonsen Elektro, Elektrisk Bureau/ABB and a Norwegian research organisation tried to develop a coordinated system of products to compete internationally. Problems at Simonsen Elektro, and the effects of the ABB-merger, led to the termination of the project, however, and Norway did not become a GSM-contender.

The situation around 1990 for Norwegian mobile telephony may be compared to the situation following Tandberg's bankruptcy.⁴⁵ Mass market opportunities for mobile telephony and colour televisions were not exploited by Norwegians. The two situations were very different, but in some respects they may both have reflected a lack of managerial strength. Tandberg's managerial strength was pulverized through the drawn out process of fighting against the market, and the new owners of Tandberg after the bankruptcy saw the television challenge as too big – which it probably was for people without industry experience.⁴⁶ In mobile telephony there was no company that could take the lead. There was an abundance of technical competence in companies and research institutions to support a Norwegian entry into mobile telephony around 1990. But entry demanded entrepreneurship and financial commitment of a kind that was harder to find.

Simonsen Elektro was a natural candidate because of its market positions (Simonsen made highly regarded quality-phones), but the increased international competition in the NMT-business added to the particular Norwegian economic downturn at the end of the 1980s made an effort difficult. CEO and part owner Simonsen, who had the experience and competence needed for such an effort, was almost into his eighties and ended up selling the company. The comparison between Norway and Finland at the inception of GSM technology is instructive. Both countries possessed similar competences in relevant fields, but Nokia was financially more powerful, had a broader competence base than Simonsen, and was much better commercially positioned within NMT than Simonsen.⁴⁷ The other company that could have played such a role in Norway, Elektrisk Bureau/ABB Norway, continued its effort for some time, but chose in 1990 to sell its Telecom business to Ericsson, creating Ericsson Norway. Perhaps there was some

Swedish coordination on the part of ABB/Ericsson getting rid of a possible Norwegian contender, but in 1990 Ericsson had yet to formulate a strong strategy for GSM growth.⁴⁸

Following the fall in oil prices, the early 1990s was a period of economic problems in Norway. It was a period of consolidation, and no company consolidated more than ABB Norway, the successor to Elektrisk Bureau: It reorganized its electricity business, sold its telecom business and went full-throttle into petroleum-related activities.⁴⁹ Much activity in Norway has since the 1970s gone in the petroleum-direction, crowding out other kinds of investments. ABB Norway proved to be a huge success in the 1990s, proving that getting rid of telecom and concentrating on oil-related activities was hardly the wrong decision. STK/Alcatel did try to pick up the pieces, i.e. continue state-supported research programs, after Simonsen etc. gave up, but the effort did not get French backing.⁵⁰ To cut a long story short, in Norway at the time investors feared the kind of effort that going for mass markets would entail. Why go into risky business in what was a high-cost nation when there were plenty of investment opportunities in the sector that made Norway such a high-cost location, namely oil, the attractive place to be even if price and activities had fallen since 1986? Why, indeed, go for telecom where no national purchases could be taken for granted?

The fall in oil-prices hit the remaining big IT companies of Norway hard.⁵¹ According to figure 1 the only real downturn in terms of reduction of employment after 1972 is found after 1988. While the 50 percent fall in employment from 1987 to 1992 also reflects the international downturn in the beginning of the 1990s, most of this negative trend must be seen as closely related to the problems in the Norwegian economy. Elektrisk Bureau and STK changed fairly

gradually and according to changes in the public procurement policies, but some companies met their problems in a more abrupt and damaging way.

The first of the companies to face liquidation in 1987 was Kongsberg Våpenfabrikk, the state owned weapons-manufacturer that had been operative since 1814. The official investigation following its liquidation revealed a company that for many years had not fulfilled its budgets and had filled its financial needs directly from the Government, justified by a continuous process of investing in new and exciting technological areas.⁵² What happened – stated more crudely – was that the new political climate exemplified by the Tandberg bankruptcy finally caught up with Kongsberg Våpenfabrikk when the oil price fell in late 1986 and the economic boom of the 1980s wound down. Government spending was dramatically cut both to stabilize the economy and to reflect the lower level of petrol taxes. Kongsberg, who remarkably had been refinanced several times during the 1980s, was turned down – for the first time – when it asked for more money in 1987. Several new companies were created after the demise of Kongsberg Våpenfabrikk; the largest were Kongsberg Gruppen (defence electronics, state owned), Kongsberg Offshore Systems/FMC Kongsberg (for underwater oil-production systems), Kongsberg Automotive (for car parts) and a few others. A great hit of the 1980s until the oil price fell – Kongsberg Albatross, the world leader in dynamic positioning equipment – was sold for a song to collaborator Simrad. Albatross had been viewed as a great success in the modernization of Kongsberg Våpenfabrikk by extensive use of IT.

The next big casualty was Norsk Data, for a long time the most successful Norwegian IT company of the 1980s.⁵³ While Norsk Data's initial success depended on being an innovator in

the mini computer market, its strategy throughout the 1980s left it very vulnerable when the cuts in Norwegian Government spending hit the Norwegian public sector, an important market for Norsk Data. Originally started as a seller of mini machines, to a wide variety of users, in many countries, Norsk Data tried to become a systems provider selling programs and packages most notably for various organizational tasks, often made in collaborations with Norwegian government agencies and partly financed through R&D contracts. The coming of the PC (personal computer), open systems and its dependence on the Norwegian market, all contributed to Norsk Data's fall. When public Norway stopped purchasing from Norsk Data, the company failed. Norsk Data was not alone in failing, of course, and to some degree the downfall of Norsk Data and Tandberg reflected new developments in highly competitive international markets. In contrast to Tandberg, Norsk Data did not really have a sophisticated strategy for surviving such international and technological competition. Norsk Data and its emphasis in developing closed-system applications for its computers resembled market leader Digital Equipment Corporation, also a company that failed.⁵⁴ Indeed, Norsk Data was hardly alone in failing as a mini computer company. But like Kongsberg Våpenfabrikk, Norsk Data failed to meet market expectations and failed to recognize how the new political realities of Norwegian technology policy, which had weakened the positions of "national champions," had increased its vulnerability to market competition.

The 1980s changed the Norwegian system of innovation for IT. Superficially, there were still numerous contacts between Government loan institutions and the Norwegian research council and the Norwegian IT sector, and some positive outcomes resulted. But the Government procured differently by the end of the 1980s. Nationally motivated purchases had been

abandoned in important markets, delimiting the influence of research policy and favourable loans to their more or less direct results. Even more dramatically, all the large actors of the sector – having meticulously been built up from the inter-war period – were gone. Tandberg and Norsk Data went bankrupt. Elektrisk Bureau and STK was dramatically reorganized, not least because there was little to be gained by having a R & D operation for telecommunications in Norway given the new policies. Televerket's R&D Institute changed gradually to play a role only for Televerket, not the outside industry. Kongsberg Våpenfabrikk did not technically go bankrupt, but was discontinued as a legal entity. Overall, the microelectronic revolution and the global competition gaining force in the 1970s had contributed to a revolutionary change for the Norwegian IT industry. There had been a regulatory change away from the political steering of this sector towards a much more market oriented situation for business. And the change was not without success.

Slow growth, small companies (1991-2006)

For the Norwegian economy, the years between 1987 and 1993 were very problematic. The fall in the oil prices hit the general level of activity of the Norwegian economy, which, when the international downturn following the Gulf war took effect, transformed itself into a full-blown property and banking crisis. On another level the political milieu in Norway finally realized that most of the high income from oil and gas had to be kept outside the Norwegian economy, so the period from around 1990 until today has been characterized by fairly steady development and a decent economic climate, not altogether bad for an internationally competitive industry.

To some degree “oil as a problem” was displaced by “oil as a solution”, as some of the more successful Norwegian IT companies found a profitable market in the Norwegian oil industry. Simrad was a forerunner here, and in addition to its products for dynamic position systems for seabed mapping by hydro-acoustics were made.⁵⁵ Many of the new IT products followed in the wake of the so called “Deals for technology”, a Government-induced system after 1978 that gave oil companies goodwill in the process of handling out new concession for oilfields if they purchased Norwegian technology.⁵⁶ Some of the deals made between Norwegian companies and oil companies were not about oil related activities at all, and Norsk Data was a huge benefactor. But some new products were developed in response to this new source of demand, and the full effect of this influx of fresh research money is hard to grasp in all its complexity.

This new policy reflected the character of the changes in economic policy of the late 1970s. Gone were the days when the Government directly supported companies like Tandberg. That was dangerous for the Government when Tandberg failed. Gone were the days (they were never many) when large contracts given by the Government directly supported companies. That could also be dangerous for the Government. But “rigged” markets, the political construction of new networks between foreign oil companies and Norwegian technology-providers, giving the oil companies benefits later, was for some years after 1978 a viable alternative. Norway most certainly did not convert to anything like pure and principled liberalism in the late 1970s, and the limited nature of these shifts in policy may have contributed to the lack of understanding of the political changes on the part of Kongsberg Våpenfabrikk’s leadership.

The companies benefiting the most in various ways from the oil economy may have been the successors of Kongsberg Våpenfabrikk. First, the maker of underwater production systems (and a firm whose products and technologies spanned much more than IT), Kongsberg Offshore Systems/FMC experienced a commercial breakthrough when underwater production systems by and large came to replace large platforms.⁵⁷ Kongsberg Gruppen, the defence-products company and the real successor to Kongsberg Våpenfabrikk, adapted to the changing geopolitical climate after 1990 with a series of acquisitions of companies in maritime electronics, including Norcontrol, previously under the Kongsberg umbrella. The large and important purchase was Kongsberg's unfriendly takeover of Simrad in 1996, and Simrad became the cornerstone in Kongsberg Maritime, which in addition to Kongsberg Defence and Aerospace was one of the two significant parts of Kongsberg Gruppen. Kongsberg Maritime had a range of offshore customers, but oil related activities were the significant market for this new entity.⁵⁸

It is difficult to quantify the positive role of oil for the IT industry of the 1990s. For Kongsberg Maritime it played a significant role as a market for the company. For Kongsberg Offshore System and ABB's oil business IT was an integral part of larger technical systems and therefore important for the development of new and complex products. For the telecommunications sector developing an infrastructure for the Norwegian petroleum sector has been an ongoing task covering several technological phases and different actors.⁵⁹ The single most compelling illustration of oil's helpful role may just be that the largest IT company of Norway, Kongsberg Gruppen, is the one company where oil clearly has meant the most. This is also the one company most clearly building its future on the technical past of two of the most important companies of the postwar era, namely Kongsberg Våpenfabrikk and Simrad.

The rebuilding of a strong Kongsberg group created the only major new IT industrial enterprise in Norway during the 1990s. Otherwise the 1990s and the ensuing years of the new decade have been characterized by organic growth of old and new enterprises. Most of the largest enterprises of this period were remnants of the former large enterprises. The revival of the Tandberg-companies was the most remarkable phenomenon. Apart from the computer company, Tandberg Data, that has recently been split in two, the company that was the continuation of Tandberg Radiofabrikk became in the early 1980s rather dormant. Its revival, which eventually led to the creation of two companies, was based on new technology from Televerket's R&D Institute. Both technologies were concerned with moving pictures, and one of the companies make equipment for telephony with live pictures, while the other one makes equipment for satellite transmission of live pictures (television). There are several off-spins from Elektrisk Bureau, STK and Norsk Data, and while never a commercial success the maker of integrated circuits, AME, has spawned a number of different companies.

The biggest success of all, albeit one that was not an industrial firm, was the international success of Telenor, the part-privatized old Televerket that was able to grow significantly abroad, not least through becoming mobile operator in several countries. Telenor has been a clever strategist, but all three observers of Telenor and the Norwegian telecom industry have thought that what was the Norwegian telecom industry's loss was Telenor's gain.⁶⁰ While STK and Elektrisk Bureau went down, Telenor went up. Telenor's success relied on a number of factors such as the input from Televerket's R & D Institute, its own work to modernize the Norwegian infrastructure, which reached a high point with the specifications for the digital switch contract

in 1983, and a continued input of highly qualified and very experienced people who somehow were made redundant with the demise of Elektrisk Bureau and STK.

Industrial reorganisation also had other ramifications. In the wake of the dramatic reorganization of Simrad in the early 1980s, following a strategy that Tandbergs Radiofabrikk rejected, considerable production activity has been outsourced. Other IT companies have followed Simrad in outsourcing production. Out of this development several new companies have been formed, and Kitron, a specialist in the making of IT goods, has become a – in a Norwegian perspective – fairly large company specialising in contract-production. The making of specialized production companies underlined the transformation of traditional, manufacturing-oriented electronics firms into information manipulating companies with strong engineering footings. To a large degree this entailed a generational shift within the companies, and if the case of Simrad is representative, the R & D departments of these firms now are filled with “young people” skilled in digital technology.⁶¹ A specialised company like Simrad had many positions for “old” engineers, however, not least in a sales-force that was active globally.

What were the dynamics of the 1990s? To some extent, of course, the IT industry built on past achievements and new market-opportunities. But most of these companies had to reinvent their market positions and reconstruct their efforts in new ways. The situation – with Kongsberg being the exception – called more for reliance on new brains rather than accumulated corporate knowledge and culture. The continued development of a small scale Norwegian IT industry must to no little extent reflect the continuous input of newly educated engineers able to master new technological and commercial challenges. Indeed, the influx of highly educated young people

willing and able to adapt to rapidly changing circumstances, more often than not in a national rather than an international context, has been a historic hallmark and strength of the Norwegian IT industry throughout the past century.

The continued growth of the industry during the 1990s and 2000s tell a story of a quiet revival. The stock-market crisis of 2000 was remarkably good to the Norwegian IT industry, something that may be explained by a certain lack of a “bubble frenzy” in the Norwegian industry prior to the crisis. Indeed, one success factor in this period may be the realistic attitude within the industry, an attitude that parts of the industry had ample opportunity to develop during the 1970s and 1980s. There is nothing bold and flashy about the Norwegian IT industry of 2007, and the various hypes of history’s yesterdays – “information” or “knowledge” economy, “high tech industry”, “new economy” – seem left behind. That is partly because there is so little that is flashy left, and the Norwegian IT industry of today is finding its niches, a lot of them strongly related to needs – past and present – in the Norwegian economy.

Conclusion

Seen in a strictly comparative perspective, Norway is the Nordic IT industrial laggard, not too far behind Denmark. Seen against the huge ambitions industrial actors and politicians have had during 1970s and 1980s for international success, the Norwegian IT industry is a failure.

Measured against all the company failures and the many situations of crises, the Norwegian IT industry has failed in ways that have left many people in economic misery. But the Norwegian industry has survived, it has developed and eventually resumed growth, and it was able through painful changes to adapt to technical change, global challenges and new opportunities. It has

throughout the twentieth century, and not least during Norway's oil boom, been an important competence in the broader transformation of the Norwegian economy. While comparing Norway to other nations gives interesting perspectives, the most important lesson to be learned from the history – recent as well as old – of the Norwegian IT industry is its integration into the rest of the economy. The failure of the Norwegian IT industry to develop products for huge foreign markets may have benefited at least some other sectors of the Norwegian economy, who have had partners to make specialized products needed for particular purposes.

This development has been characterized by both continuity and change. The most dramatic change has come in the fortunes of the companies. Some of the company failures have also meant the extinction of whole sectors of the Norwegian electronics industry, as consumer electronics, computers, mobile telephony, have vanished. But smaller organizations, making equipment for the maritime sector, building on old competences, have continued, and have contributed to larger economic activities within Norway– running boats, the process industry, the whole oil business. The influx of oil in the Norwegian economy has been particularly important in this recent history, contributing a complex mix of higher factor costs (1970s and 1980s in particular) and volatile markets (rapid changes in public sector spending in 1980s) on the one hand, while on the other representing new markets for specialized products as well as giving grants and helping with finance of R & D. The huge oil sector has also sucked managerial and engineering talent away from IT production, as well as representing a very attractive market for private capital looking for new opportunities.

Seen against this background, the Norwegian IT industry represents something of a success story, as the industry has contributed to Norwegian economic growth based on natural resources being utilized by advanced technology. More than that, the history of the Norwegian IT industry – building on its forerunner the electronics industry and preceding the IT service and software sector – may, perhaps, be seen as a case of how the whole Norwegian IT sector have been functioning, namely as an integral part of the Norwegian economy. General Norwegian economic growth – and Norway is one of the richest nations in the world per capita – has been strong, and the IT industry has more than contributed its part in this success.

Notes

¹ My interpretation of the development of the Norwegian IT industry has benefited from many people over the years, most recently from doctoral candidates Sverre A. Christensen, Stein Bjørnstad and Gard Paulsen. Comments from Jan Fagerberg, Sjur Kasa, David Mowery and Olav Wicken at the IPP workshop at Leangkollen was helpful.

² See table 7.6 and figure 7.17 in: Nordic Council of Ministers, Nordic Information Society Statistics 2005, Copenhagen 2005

³ See: Knut Sogner, Næringspolitikkenes betydning for fremveksten av norsk elektronikk- og IT-industri, i Olav Spilling (red.), *Kunnskap, næringsutvikling og innovasjonspolitik*, Bergen: Fagbokforlaget 2006

⁴ Harald Rinde, *Et telesystem blir til: Norsk telekommunikasjonshistorie*, bind I, Oslo: Gyldendal Fakta 2005

⁵ This is the main argument in: Knut Sogner, *En liten brikke i et stort spill. Den norske IT-industrien fra krise til vekst 1975-2000*, Bergen: Fagbokforlaget

⁶ The Global Information Technology Report 2006-2007, World Economic Forum's homepage

⁷ Gunnar Nerheim and Helge W. Nordvik, *Historien om IBM i Norge 1935-1985*, Oslo etc.: Universitetsforlaget 1986; Sverre Knutsen, Even Lange and Helge Nordvik 1998, *Mellom næringsliv og politikk. Kreditkassen i vekst og kriser 1918-1998*, Oslo: Universitetsforlaget 1998

⁸ Keith Smith, Hva slags økonomiske virkninger har IKT skapt?, i Helge Godø (ed.), *IKT etter dotcom-boblen*, Oslo: Gyldendal akademisk 2003

⁹ Statistics Norway, "Databehandlingsvirksomhet ... 2004", sent by Ole-Petter Kordahl

¹⁰ Interview with Tom Gerhardsen

¹¹ See Jan Rune Holmevik, Educating the machine. A study in the History of Computing and the Construction of the SIMULA Programming Language, report number 22, University of Trondheim: STS1994. Gard Paulsen is currently writing the doctoral thesis "Innovating code and coded innovations: The dynamics of the software industry 1965-2005 at the Norwegian School of Management BI.

¹² OECD & Nordic Information Society Statistics 2005, Copenhagen: Nordic Council of Ministers

¹³ *Elektronikkindustri*, Oslo: Norges Offentlige utredninger, 1976: 30

¹⁴ Se Keith Smith 2003 op.cit. for more about the difficulties with ICT statistics

¹⁵ Sverre A. Christensen, Switching relations. The rise and fall of the Norwegian telecom industry, Oslo: Handelshøyskolen BI 2006

¹⁶ Knut Sogner, *God på bunnen. Simrad-virksomheten 1947-1997*, Oslo: Novus forlag 1997

¹⁷ John Peter Collett (ed.), *Making Sense of Space. The History of Norwegian Space Activities*, Oslo: Scandinavian University Press 1995

¹⁸ Tor Arne Eilertsen, Fra FOTU til FFI. Grunnleggingen av norsk forsvarsteknologisk forskning 1942-46, unpublished hovedoppgave in history, University of Bergen 1987

¹⁹ Per Fremstad, 40 år med radiolinjer 1955-1993, unpublished booklet, Bergen 1993

²⁰ Knut Sogner, Veksten mot idealfabrikken, rapport nr. 5, *Teknologihistorieprosjektet, NAVF-NTNF*, Oslo 1990

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- ²¹ Olav Wicken has written extensively on this subject, see for example: Olav Wicken, Norske våpen til Natos forsvar, *Forsvarsstudier*, nr. 1, 1987 and Olav Wicken, Stille propell i storpolitisk storm, *Forsvarsstudier* nr. 1, 1988
- ²² Olav Njølstad and Olav Wicken, *Kunnskap som våpen. Forsvarets forskningsinstitutt 1946-1975*, Oslo 1997
- ²³ Sogner 2002 op.cit.
- ²⁴ Håkon With Andersen, *Fra det britiske til det amerikanske produksjonsideal. Forandringen av teknologi og arbeid ved Aker mek. Verksted og i norsk skipsbyggingsindustri 1935-1970*, Trondheim: Tapir 1989; Knut Sogner, *Fra plan til marked. Staten og elektronikkindustrien i 1970-årene*, Oslo: TMVs skriftserie/Pensumtjeneste 1994
- ²⁵ John Peter Collett og Bjørn O.H. Lossius, *Visjon-Forskning-Virkelighet. Televerkets Forskningsinstitutt 25 år*, Kjeller 1993
- ²⁶ Christensen 2006 op.cit.
- ²⁷ Sogner 1994 op.cit.
- ²⁸ Kjersti Jensen, Moderniseringsmiljøet som pådriver i norsk industriutvikling på 50 og 60-tallet, unpublished hovedoppgave in history, Universitetet i Oslo 1989
- ²⁹ *Elektronikkindustri*, Oslo: Norges Offentlige utredninger, 1976: 30
- ³⁰ Sogner 1990 op.cit.
- ³¹ Sogner 1990 op.cit.
- ³² Letter from Andreas Skogvold to Knut Sogner, July 1989
- ³³ Erik Arnold, *Competition & Technological Change in the Television Industry. An empirical Evaluation of Theories of the Firm*, London: MacMillan 1985. For the Japanese development, see Gene Gregory, *Japanese Electronics Technology*, Chichester: John Wiley & Sons 1986
- ³⁴ Sogner 1994 op.cit. and Sogner 2002 op.cit.
- ³⁵ Signy Overby, *Fra forskning til industri. Utviklingen av skipsautomatiseringsbedriften Norcontrol*, uupublished hovedoppgave in history, Universitetet i Oslo 1988; Norges Offentlige Utredninger 1989: 2, Kongsberg Våpenfabrikk
- ³⁶ Sogner 1994 op.cit and Christensen 2006 op.cit.
- ³⁷ Sogner 1997 op.cit.
- ³⁸ John Peter Collett og Bjørn Lossius, *Visjon –forskning – virkelighet. Televerkets Forskningsinstitutt 25 år*, Skedsmo: Televerkets forskningsinstitutt 1993
- ³⁹ Christensen 2006 op.cit.
- ⁴⁰ Christensen 2006 op.cit.
- ⁴¹ Christensen 2006 op.cit.
- ⁴² Sogner 2002 op.cit.

⁴³ Sogner 1994 op.cit.

⁴⁴ Christensen 2006 op.cit.

⁴⁵ The following discussion is based on Sogner 2002 op.cit. who draws upon several other works.

⁴⁶ They had taken over Tandberg after receiving a huge help-package from the Government.

⁴⁷ I am basing this comparison on my own and Christensen's (2006) work in addition to Ari Hyytinen, Laura Paija, Petri Rouvinen and Pekka Ylä-Antilla, Finland's emergence as a Global Information and Communications Technology Player: lessons from the Finnish Wireless Cluster, in: John Zysman and Abraham Newman, *How Revolutionary was the Digital Revolution? National Responses, Market Transitions and Global Technology*, Stanford: Stanford Business Books 2006

⁴⁸ Maureen McKelvey and Francois Texier, Surviving technological discontinuities through evolutionary systems of innovation: Ericsson and mobile telecommunication, in Charles Edquist and Maureen McKelvey, *Systems of Innovation: Growth, Competitiveness and Employment*, Vol. II, Cheltenham, UK 2000

⁴⁹ Sogner 2002 op.cit.

⁵⁰ Christensen 2006 op.cit.

⁵¹ Sogner 2002 op.cit.

⁵² Norges Offentlige Utredninger: "Kongsberg Våpenfabrikk, NOU 1989: 2

⁵³ Sogner 2002 op.cit.

⁵⁴ For DEC, see Alfred D. Chandler jr., *Inventing the Electronic Century. The Epic Story of the Consumer Electronics and Computer Industries*, New York: The Free Press 2001

⁵⁵ Sogner 2002 op.cit.

⁵⁶ Kjell Grønhaug, Torger Reve og Tor Fredriksen, "Teknologiavtalene: samarbeidsaktiviteter og samarbeidsvirkninger", rapport 1/86, *Senter for anvendt forskning*, NHH. See also Olav Wicken: "The Role of R&D in Industrial Policy: Rise and fall of a research driven strategy for industrialisation", *TIK Working Paper on Innovation Studies No. 20070603*

⁵⁷ Stein Bjørnstad, Forklaringsmodeller for "århundrets største ingeniørbragder", i: Olav Spilling Olav Spilling (red.), *Kunnskap, næringsutvikling og innovasjonspolitik*, Bergen: Fagbokforlaget 2007

⁵⁸ In addition to Sogner 2002 op.cit., Stein Bjørnstad is writing a doctoral thesis about the oil-related activities of the Kongsberg companies that goes detailed into the history of dynamic positioning and under-water production systems.

⁵⁹ Gard Paulsen, Innovasjon over Nordsjøen: Telekommunikasjoner på norsk sokkel, Forskningsrapport 3/2005, Handelshøyskolen BI

⁶⁰ Sogner 2002 op.cit., Christensen 2006 op.cit., Lars Thue, *Nye forbindelser (1970-2005)*, book 3 in Norsk telekommunikasjonshistorie, Oslo: Gyldendal fakta 2005

⁶¹ Sogner 2002 op.cit.

TABLE 1: Turnover and number of employees in the ICT sector (over total population)

| Country \ Year | Turnover (EUR) | | | | Number of employees | | | |
|----------------|----------------|--------|--------|--------|---------------------|--------|--------|--------|
| | 2000 | 2001 | 2002 | 2003 | 2000 | 2001 | 2002 | 2003 |
| Norway | 5056.1 | 5536.7 | 5217.5 | 4354.7 | 0.0189 | 0.0214 | 0.0187 | 0.0158 |
| Finland | 4791.7 | 5137.1 | 5041.5 | 5247.8 | 0.0211 | 0.0225 | 0.0207 | 0.0209 |
| Sweden | 7112.3 | 6388.5 | 5823.3 | 5338.4 | 0.0234 | 0.0258 | 0.0224 | 0.0200 |
| Denmark | 4987.3 | 5107.0 | 5060.0 | 4765.9 | 0.0195 | 0.0196 | 0.0181 | 0.0173 |

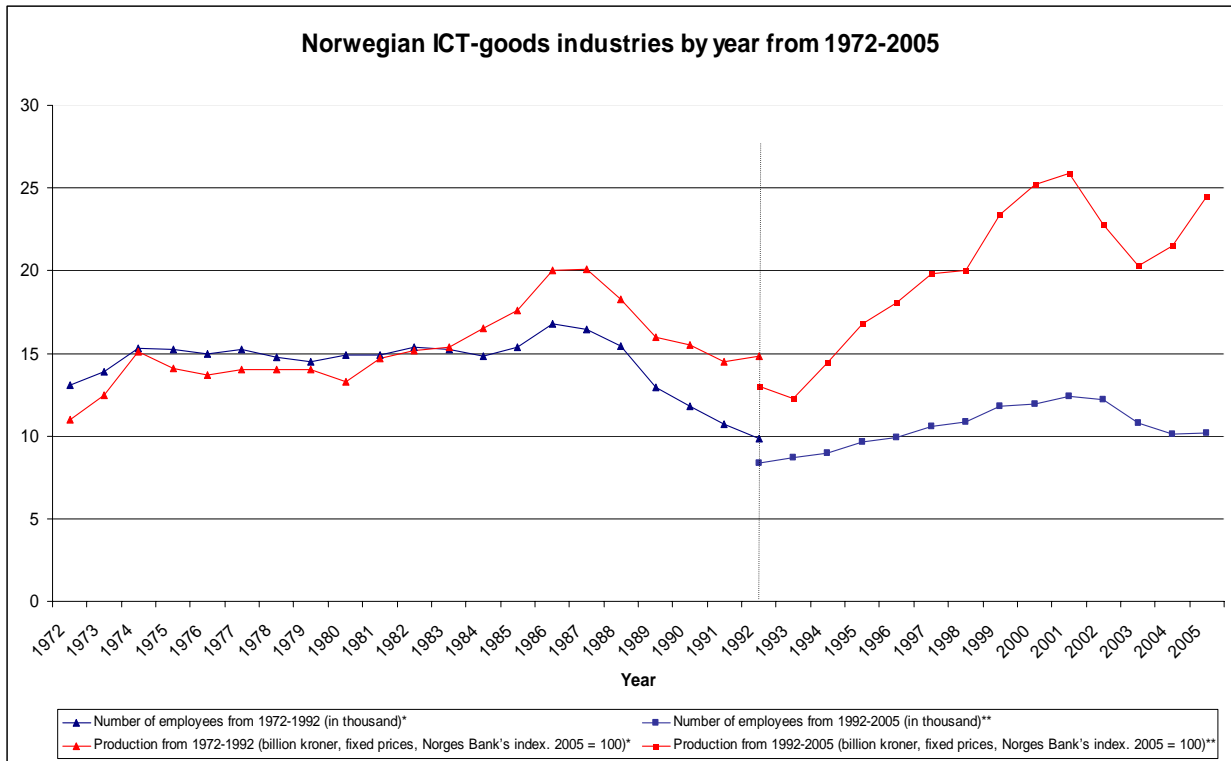
Source: OECD & Nordic Information Society Statistics 2005, Copenhagen: Nordic Council of Ministers

TABLE 2: ICT Goods

| Country \ Year | ICT goods* | | | | |
|----------------|------------|------|------|------|------|
| | 1973 | 2000 | 2001 | 2002 | 2003 |
| Norway | 2.2 | 3.4 | 3.6 | 3.9 | 3.1 |
| Finland | 1.1 | 20.9 | 19.6 | 19.8 | 17.7 |
| Sweden | 4.0 | 14.1 | 11.9 | 9.2 | 7.4 |
| Denmark | 3.2 | 4.4 | 4.3 | 4.5 | 4.3 |

*as percentage of total national industrial sales (sources: *Elektronikindustri*, Oslo: Norges Offentlige utredninger, 1976: 30 and personal communication from Ole-Petter Kordahl, Statistics Norway as a supplement to: Nordic Information Society Statistics 2005, Copenhagen: Nordic Council of Ministers)

FIGURE 1: Norwegian ICT-goods industries by Year from 1972 – 2005



* Source: Statistics, Norway. From Nils Petter Skirstad. Based on the ISIC-classification (1973-1992).

**Source: Statistics, Norway. From Nils Petter Skirstad. Based on the NACE-classification (1992-2005).