Successful innovation and establishment of high-tech industry in Tromsø

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Abstract — *This pape r is based on results from the project "Study of successful innovation and establishment of high -tech industry in Tromsø region". The focus of this paper is the collaboration between research and educational institutions and the industry as several of the innovation and high -tech companies are based on research projects. The paper gives an overview of theories of innovation system and discusses innovation and related terms from a technological viewpoint. From the top-level the national and regional innovati on systems are based on governmental policy on several areas: industrial policy, research and educational policy, tax rates on high -risk investments and funding of new industries. Relevant statistics showing demand for better funding of research and new in dustries are presented. On the medium -level the theory of clusters is applied, where the research and educational system is important for establishment of high -tech industry. Establishing new industry from research projects, participation in projects (rese archers, academic staff and students) developing new products, production processes or improvement of those, and supplying the industry with skilled employees are all -important. On the lowest level are the conditions for the individual entrepreneur. Even a successful establishment can ruin the entrepreneur because of taxes on shares, and when there is demand for new capital, the original owners share are reduced and they loose control of the company. New investors often demand full control and buy out the o riginal owners for a very low price, and the entrepreneur is often the looser in such an agreement. A lot of things can be done to improve conditions for entrepreneurs, for instance providing better funding, less tax on shares and a safety network for entr epreneurs. The paper gives a short history of research and industry in Tromsø. Successful establishment of high -tech industries can be traced back to research institutions (for instance the 75 year's old Aurora observatory, the Tromsø satellite station and the university). Benefits and drawbacks of the location in the far north of Norway (at 70 degree latitude) are discussed. Selection criteria and examples of successful compa nies are presented. We also give examples of the innovation process and establishm ent of the companies. A section describes what the engineering education in Tromsø does to stimulate innovation and entrepreneurship, and what can be improved (courses in innovation and entrepreneurship, offices for new companies established by new enginee rs, students running companies as a part of the curriculum, Norwegian networks (InnovationNet) for academic staff to upgrade competence and exchanging experiences). The traditional Norwegian industry has been based on production of raw materials, based on natural recourses and/or cheap hydroelectric power (i.e. production for aluminum and silicon). As for export, fish is the second largest export article (after oil). The industry has downsized and emigrated over the last years, and a lot of industrial workp laces are lost. This gives a high demand for innovation and entrepreneurship resulting in the establishment of successful high -tech industry, a process where the engineering educations must participate.*

Index Terms — *Norwegian innovation systems, Norwegia n innovation policy .*

INTRODUCTION

This paper is based on results from the project "Study of successful innovation and establishment of high-tech industry in Tromsø region". The focus of this paper is the collaboration between research and educational institutions and the industry as several of the innovation and high-tech companies are based on results from research projects.

When this project started in 2003, Norway had lost several (ca. 17.000) workplaces in the traditional industry over the last years. The industry downsized, emigrated or closed down because of competition in the global markets. The reasons for this were high interest rate, high currency exchange rate for Norwegian Krone (NOK), high salaries and high cost of living. Fortunately, during the first half of 2004, the conditions have been better by lower interest rate, lower exchange rate (for NOK) and stabilized cost level. The high price of oil gives also high income to Norway, the third largest oil exporter in the world. For the third year Norway is nominated by UN to be the best country to live in. But it is not probable that the lost industrial workplaces will come back, so it is important to create new.

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My interest for innovation, entrepreneurship and collaboration with the industry comes from teaching Software Engineering and advising student projects in the industry, and being a member of InnovationNet – a national network at the University Colleges with the goal to extend the competence and include innovation and entrepreneurship in the programs.

The main objective of the project is to study innovation and entrepreneurship in technology based industry in Tromsø, with sub objectives:

- Study the innovation system and the interactions between the actors
- Study conditions for establishment of new technology based businesses (in Tromsø)
- Study innovation in successful technology based businesses

The methods used are study of plan document, research reports, business newspapers, internet information from selected companies, university and research institutions and governmental institutions etc., case study of innovation in a companies, interviews and conversations with persons in the companies and innovation system, and presentations of policy plans and successful innovations at conferences. The complete project results will be presented in a research report (not finished yet).

History of research and industry in Tromsø

The section gives a short history of research and industry in Tromsø. I was bourn in Tromsø (in 1952), and have lived here almost all my life, from 1977 to 1993 I had several positions at the University of Tromsø, and from 1993 I have been assistant professor at Tromsø University College. I have also been board member of The Norwegian Computer Society and board member and chairman of the local society of Tromsø, board member and chairman of Tekna (The Norwegian Society of Chartered Technical and Scientific Professionals) department of Tromsø, and the national group for Tekna members at Norwegian University colleges. Those positions give me several viewpoints to the history of research and technology, especially Information and Communication Technology (ICT) in Norway and Tromsø.

Successful establishment of high-tech industries can be traced back to research institutions. The location of Tromsø in the far north of Norway (at 70 degree latitude) has both benefits and drawbacks.

The Aurora Observatory is 75 years and was located in Tromsø because of good conditions for doing research on aurora and the ionosphere, and good infrastructure compared to other locations at the same latitude. The observatory is now included in the Faculty of Science of the University. Tromsø Satellite Station was established in the late sixties of the same reasons, and that data from almost every passes of polar orbit satellites can be read. Those institutions had high competence in electronics, and were early users of computers in science and technical applications. Tromsø has also been the starting point for several research expeditions to the arctic.

The University of Tromsø was established in 1972 because of the research institutions, the hospital and it was a center for governmental and local administration, and have a large fish industry and businesses supporting those.

The strong administration and business enterprises were the reason for the establishment of ICT companies. Before 1970 we had two mainframe computer centers, one supporting governmental and local administration, the other supporting banks and other businesses. From those companies there have been several establishments of new ICT businesses. The University had computer science department and computer center from the beginning, and got its own mainframe computer in 1978. A more detailed history is given in the project report.

INNOVATION SYSTEMS

This section gives an overview of theories of innovation system and discusses innovation and related terms. A top-down three level approach starts with the top level innovation policy, then the medium level of innovation systems where we have local clusters, and at the bottom level we have the innovation management in a business, and process of the establishment of new businesses (based on a new product).

The term innovation has a very wide meaning. In this context it refers to a new or improved product, service or production process, or a new or old product introduced in a new market. The purpose is all over to generate economic value. Technologists are most interested in the innovation of product and production processes!

Innovation policy

From the top-level the national and regional innovation systems are based on governmental policy on several areas: Industrial policy, research and education policy, tax rates in general, and especially on high-risk investments and funding of new

industries. In the global market the Government controls the national interest rate and the currency exchange rate Norwegian Krone (NOK).

The innovation policy of the Norwegian Government is stated in several documents, the most recent is the plan called "From Idea to Value" [1] published late 2003 with the following vision: "Norway shall be one of the most innovative countries in the world, where resourceful and creative enterprises and people are given opportunities for developing profitable business. Norway shall be in the lead internationally in important areas, in terms of knowledge, technology and welth creation". The plan has statistics indicating the situation today where Norway is compared to OECD countries and to our neighboring countries (Sweden, Denmark and Finland).

The plan lists several goals ([1], p. 14), and five areas that define the setting of the Government's policy:

1. General conditions for trade and industry
2. Knowledge and competency
3. Research, development and commercialization
4. Entrepreneurship – starting up new business
5. Electronic and physical infrastructure

The following sections give a short summary of the plan, with focus on points important for research and engineering education, and collaboration with the industry.

General conditions for trade and industry

This point ([1], p. 16-21) have a number of goals on general improvement of competition regulation, public procurement, taxation system, regulation and stimulation of the capital market, conditions for recruitment and use of manpower, user friendly public services and reduction of administrative burdens. This include stimulation by tax reduction on investment in research and development, better quality and more efficient public services (internet based), better regional funds, reorganization of the Norwegian Fund system (Innovation Norway), and better information flow from business to Government.

Knowledge and competency

The goal of this point is "An outstanding system for learning and education, offering industry access to people with relevant knowledge of high quality" ([1], p.22). The chapter gives a description of the education policy and the reforms planed and implemented the last years. For the innovation policy science and technological knowledge and competence are important for the industry and for engineering education. The population has relatively high education compared to other European countries, but as the status is for several Western countries, science and technology have problem with recruitment of students. The organizations of industrial companies send out warnings for the consequences for the technical competences in the society and recruitment. There are several projects to stimulate young people's interest for mathematics, science and technology, but so far the results are low.

The chapter also describes projects to stimulate lifelong learning to extend the competency in the industry using flexible learning models, including distant and e-learning.

The last section of the chapter expresses goals for better interaction between industry and the education and research institutions, as they are in innovation systems. In the last revision of the University and University College Act (2002), the institutions are given greater responsibility for cooperation with the industry (and the rest of the society) and performing commission research.

It is also a goal to improve mobility between various industries and sectors, and between academia and business, and thereby exchange knowledge.

Research, development and commercialization policy

The Government's objective is more research-based industry ([1], p.27). To achieve this Government will: "Reach the OECD average research effort by 2005, pursue the increased quality and internationalization of Norwegian research, stimulate to increased research and development in the industry, promote commercialization of research findings and stimulate improved interaction between knowledge institutions and business communities".

Research is fundamental for innovation and creation of new industry and business. Norway's investment in research is low, only 1.62 % of GDP (industry ca. 51 %, Government ca. 40 % and other/foreign interest ca. 10 %, [1], p.27), and this is the lowest in the Nordic region. In EU it is 1.93 % of GDP and the goal is to increase it to 3 % in 2010, 2/3 of this investment in the industry.

Collaboration between the research community and industry is important in the innovation system in several ways. Results from research is commercialized in existing industry, or is basis for establishing of new business, exchange of knowledge by commission research, recruitment of graduates and researchers, and other collaboration projects.

As the Norwegian industry consists of a lot of small and medium-sized businesses geographically spread out over the country, the internal research and development investments are relatively low, so they are dependant of collaboration with a distributed research community (universities, university colleges and research institutes which are important in local clusters). To increase the internal research it is established funding system with tax reduction (SkatteFUNN, [2]), funds and support from [3] and Innovation Norway [4].

The Research Council of Norway which was reorganized in 2003 has several programs to extend industrial research and promote innovation, and will establish a national network in collaboration with Innovation Norway.

There are also programs to extend commercialization from research, for instance the FORNY program [5] funded by the Research Council and Innovation Norway, where ideas from universities, university colleges and research institutes get grants, loans and help in the commercialization process, and there are research parks with incubators to help new businesses in the start up. The universities has also established technology transmission offices (TTO) and are given responsibility to be an active partner in the commercialization process and help to protect immaterial property rights (patents etc.), according to amendments in the University and University College Act [6] and the Employee Invention Act [7].

Entrepreneurship – starting up new business

The Government's objective is ([1], p.33): "More new start-ups with a potential for growth. To achieve this Government will: Strengthen entrepreneurship training in schools and in higher education, make it simpler to start up a new business in Norway, target direct policy instruments at entrepreneurs, young business, and small and medium-sized business with a potential for growth, contribute to improved risk management and access to capital in early stage."

The entrepreneurship activity in Norway is high, ca. 20,000 to 25,000 new enterprises are registered each year, but only half survive the first five years, and only 0.5 % are new technology-based business focusing on export markets ([1], p.33). Establishing of a new business is demanding, and in addition to the competency and skills of the entrepreneur himself, it is important to have access to good advices, to networks and to capital, which all are components in local clusters.

The policy for entrepreneurship in education is also expressed in a more detailed plan [8]. Entrepreneurship should be introduced to young people at various levels in the education system. For the engineering education there are several programs to stimulate entrepreneurship: InnovationNet, Student Business (Studentbedrift), Europrice, Grunderskolen and Business oriented program for University Colleges (Næringsrettet høgskoleprogram).

The establishment and running of new business will also be simplified, by electronic registration of new enterprises and better regulatory framework.

It is also important according to the plan to give guidance, and establishing meeting places and networks at locations in all regions of the country. This is part of the infrastructure in the clusters described in a later section. This includes business and science parks, different types of incubators, and regional representations of Innovation Norway and the Research Council of Norway. There will be established a joint Internet user interface to business-oriented policy instruments and network of offices, both in Norway and abroad. Innovation Norway includes international representations to promote export from Norway and transfer of knowledge and competence.

The last subsection describes access to competent capital. Most new businesses need external capital in the period from establishment to them is established in the market and get income. In this period in addition to capital from the entrepreneur himself, loans from banks (on the entrepreneurs risk), external investors, capital from venture funds and so-called Business Angels". There are established nationwide seed capital funds by the Government.

Infrastructure

The Government's objective is ([1], p.38): "An electronic and physical infrastructure promoting interaction between businesses, markets, knowledge centers and public authorities. To achieve this the Government will: Continue the development of an efficient, safe and environmentally friendly national transportation network that links the various regions to each other and ensures good international connections, promote easy access to electronic signatures and good electronic payment solutions, and facilitate effective competition in the construction of electronic communication networks, and in the development of services and content."

The geography of Norway is characterized by long distances, a long coastline, a lot of fjords and mountains and a position far north. This is of cause a great advantage for the tourist business, but it means that it is costly to build up and run a nation-wide transportation system. The climate is rather cold, especially in the northern parts. Fast and cost effective transport services are therefore important for export from Norway. In addition to the physical infrastructure, use of ICT is

important to achieve innovation in the logistics area. The information flow between manufacturer, suppliers, and customers have been faster by extensive use of ICT. The National Transport Plan [9] gives details for improving the transport system.

The electronic infrastructure includes among other things, broadband, electronic signature and payment solutions. The Government's Plans for this infrastructure is expressed in eNorway – The Norwegian Government's IST/ICT policy [10]. Broadband services are accessible in most central areas, and are now extended out to smaller communities. Internet services are also in extensively use, both in commerce, banking, governmental services and private life.

Totally, the innovation plan is promising, and it will be interesting to follow the implementation. As for other plans, the appropriations are critical. There are increased numbers of research projects in the industry that get tax reduction (SkatteFUNN), but the approbation to Innovation Norway is reduced.

Clusters in innovation

In the medium-level of the innovation system the theory of clusters is applied, where the research and educational system is important for establishment of high-tech industry. Establishing new industry from research projects, participation in projects (researchers, academic staff and students) developing new products, production processes or improvement of those, and supplying the industry with skilled employees are all-important.

The cluster theory and the triple helix model are used in a study of innovation in the Horten – Kongsberg district in Norway [11]. A cluster is defined by Porter ([11], p. 25) as "a geographical concentration of inter-connected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (e.g. universities, standard agencies, trade associations) in a particular field that compete but also cooperate".

Every company need relations to customers, suppliers and governmental authorities, they get their competency and competition ability from the industrial community they belong to. Establishment of companies is attracted to areas where the infrastructure and conditions are best, and this is a self-strengthening effect which in turn will attract even more establishments, and new business is established as spin-off from others. In the cluster it is both cooperation and competition, and exchange of knowledge and competence by for example project cooperation, employees changing jobs, and selling and buying services.

In the triple helix model there is cooperation between three groups of actors who stimulate each other to extended innovation. The groups are:

- Universities, university colleges and research institutions
- Business organizations and industry
- Governmental and local authorities in innovation and industrial policy

The model emphasizes the importance of knowledge and knowledge production (research) in innovation and establishment of new industry, and that it is close cooperation between the actors in the three groups. Studies have proved that a university is important for innovation and development of new business. An outstanding example is MIT, but the model has both national and regional validity.

The triple helix model is a refinement of the cluster by sorting actors in three groups. We can observe transactions between the groups, and internally in the groups. Examples of transactions between the groups are a researcher or group of researchers establish a new business (eventually with support or funding from the authorities), employees moving between the groups, especially from university/research to industry and governmental administration, collaboration projects and/or commission research.

Local clusters

Tromsø has strong innovation clusters which also correspond to the triple helix model. First we give a short description of the university and research community and the government and local authorities in the local innovation system, and then of the clusters in ICT and space technology.

University and research community

Tromsø has a strong research community with national and international collaboration in several fields. The following is a summary of the institutions which are central in the innovation system:

- Tromsø University (including Norwegian College of Fishery Science) [12]
- Tromsø University College [13]

- NORUT Group [14] with departments NORUT IT (ICT and earth observation research), Fiskeriforskning (fishery and aquaculture research), Medicine and Health etc.
- University Hospital of North Norway, including Norwegian Centre for Telemedicine [15]
- Norwegian Polar Institute [16] with several environmental research institutes located in the same building.

The engineering education at Tromsø University College stimulates to innovation and entrepreneurship, and offers courses in innovation and entrepreneurship, offices for new companies established by new engineers and students running companies as a part of the curriculum. The college participates in several programs in collaboration with other colleges and the industry. InnovationNet [17] is a Norwegian network with the purpose to stimulate to entrepreneurship and innovation in the education, upgrade the competence of the academic staff, and exchanging experiences. Europrise is a collaboration program between 8 university colleges to give young people practical training in entrepreneurship and develop their own business idea.

Our students carry out innovation projects in the industry likes developing new products, production processes or services, or improving those. A lot of our engineers are employed in the local business and industry.

Governmental and local authorities in the local innovation system

There are several institutions in the innovation system:

- Tromsø Science Park (NorInnova [18]) is integrated in The Norwegian Science Park Association and runs several innovation programs and funds.
- The FORNY program [5]. NorInnova is local coordinator and other research institutions get funding from the program. It gives support to commercialization of research results.
- Incubator Tromsø [19] (located in the Science Park) gives help to entrepreneurs and new business (low-priced offices, general office services, funding etc.)
- Innovation Norway [4] Tromsø office has several programs for funding establishment of new business, and is part of the national and international network.
- The NT-program (Program for Innovation and Technology in North Norway [20], located in the Science Park) gives funding and support to the industry in development of new (technology based) products, and helps to find (and fund) collaboration partners in the research community.

Business organizations and industry

There are a lot of technology business and industry with close connections to the research community, and there are clusters in several areas:

- ICT-related business, with close connection to the other clusters (it is software in everything!)
- Space related technology and services
- Fish and aquaculture technology and industry with related biochemical industry based on marine resources
- Medicine, health care and telemedicine

Several new entrepreneurs and businesses are located in the Science Park and the Incubator where they have access to the services and funding of the governmental and local innovation support system. Several research institutions are located in the same area.

Cluster in information and communication technology (ICT)

Central research partners in this cluster are Institute of Computer Science, University of Tromsø and NORUT IT. There are several large companies in the ICT business, both local and representatives of nationwide companies and networks. They covers the complete market of ICT business, and some software companies are market leaders in their business area. Other clusters have also strong cooperation with the ICT business as they develop software for their business asreas. Several of the employees have their education from the University and University College. Research results are commercialized in collaboration with the industry, or the research institutions perform commission research. The ICT companies both collaborate and compete, they exchange services, and employees change jobs between the companies.

The local society of the Norwegian Computer Society is an important meeting place for the employees. The society organizes seminars and meetings on actual subjects.

Space related cluster

Central research partners in this cluster are Department of Physics and Department of Computer Science, University of Tromsø and NORUT IT. The largest companies are Kongsberg Spacetec and Kongsberg Satellite Services with national and international collaboration with Norwegian Space Centre, ESA, NASA, other companies in the Kongsberg Group and the space related business. The companies are located close to the Aurora Observatory.

Internal innovation and the entrepreneur

At the lowest level of the innovation system is the innovation processes in each company and the conditions for the individual entrepreneur.

An effective innovation process is often the difference between success and failure. Extended costs and delay in the delivery of a product to the market has broken several businesses. In a project in 2002 [21] I studied the innovation process in DryTech AS [22], a company which has developed a new drying process for food and exports dry food to several countries (field meals for the armies, expedition meals etc.). Innovation processes on product development, production processes, marketing and organization development etc. are strongly supported from the board and the management. DryTech collaborates with the research community, suppliers and customers, especially the Norwegian Army in innovation projects, and has got support and funding from Innovation Norway and the NT Program. DryTech has employed engineers from the University College and students have carried out projects for the company.

For the individual entrepreneur even a successful establishment can ruin him or he loose control of the business or company. New investors often demand full control and buy out the original owners for a very low price, and the entrepreneur is often the looser in such an agreement. A lot of things can be done to improve conditions for entrepreneurs, for instance providing better funding, less tax on shares and a safety network for entrepreneurs.

Examples of successful technology businesses in Tromsø

There are several selection criteria which could be used to find examples of successful technology businesses in Tromsø. I will use as examples companies with technology products (or services) selling on the global market. I have selected three companies: Kongsberg Spacetec AS with a relatively long history in the space related business, AutoSim AS producing car simulators, and ObexCode AS, a young software company.

Kongsberg Spacetec AS

Kongsberg Spacetec AS [23] was established in 1984 as Drive Electronics AS by employees from Tromsø Satellite Station, and after several reorganizations and refinancing it is now owned by, and is a member of the Kongsberg Group. The company develops, manufactures and delivers ground station systems for Earth observation satellites, including meteorological system. They also give consultant services, feasibility studies, system engineering, training and support. They export system all over the world, and have completed several engineering contracts for European Spaces Agency (ESA) and other Space agencies.

In collaboration with Lockheed Martin they established a ground station centre at Svalbard (79 degrees northern latitude) that can collect data from all passes of polar orbit satellites. Now there is also a fiber optic cable between Svalbard and the mainland of Norway to transfer data. In 2002 the services of the station was transferred to Kongsberg Satellite Services which is partly owned by the Kongsberg Group.

The company is a central actor in the space-related and ICT clusters, and participate in several national and global networks for space research and technology. Many of the employees are recruited from the University and the University College, students have performed projects in Spacetech, and they collaborate in research projects.

AutoSim AS

AutoSim AS [24] was founded in 1992, and based on advanced virtual reality technology they produce complete simulation systems and visual databases for training and research purposes. AutoSim has built databases for Driver training Simulators, Ship Maneuvering Simulators, Oil Drilling Rig Simulators, Road and Tunnel Simulation Projects and others. The complete full scale driver training and driving research simulator have been exported to several countries (USA, China, Germany etc.), and AutoSim has participated in research projects.

The founder of AutoSim, Martin Hansen, is an example of an entrepreneur with background from the business and research community in Tromsø. He has founded several new technology businesses.

ObexCode AS

ObexCode AS [25] is located in the Incubator in the Science Park, and was founded by Dag Bratteli who has background from the university and FAST Search and Transfer (another Norwegian successful high-tech company with an office in Tromsø). They deliver software to the global market for infrared and Bluetooth communication, and they have an office in Oslo and a daughter company in Shanghai, China. ObexCode has got Incubator grant and is funded by Innovation Norway and local programs, and the Science Park (NorInnova) is one of the owners.

CONCLUSION

With the fast change in the industrial structure and loss of workplaces in the traditional industry, it is important to stimulate innovation, entrepreneurship and establishment of new businesses. The Government's plan for Innovation is promising, but the implementation needs contribution from several departments. The appropriation to research and funding of new business should be extended to the same level as our neighboring countries.

It is important to stimulate and motivate young people to study science and technology. Science and engineering education need special approbations to recruit more students.

The conditions for the entrepreneurs must be better, both by better funding and help from the innovation system, less tax on shares, and a safety network for entrepreneurs.

As the examples show, it is possible to establish and run high-tech businesses from the far north with long distances to markets and customers. This depends on access to good innovation system, local clusters and high competence and knowledge.

Further work in the project will be to investigate the results from the Government's Innovation plan, both on national and local level, and to study innovation in successful businesses and collaboration with the research community.

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