INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN
ICED 03 STOCKHOLM, AUGUST 19-21, 2003

ESTABLISHING AN INFRASTRUCTURE FOR VALUE CHAIN COLLABORATION IN THE NORWEGIAN OIL INDUSTRY – A CASE STUDY

Kjetil Kristensen, Hans Petter Hildre, Jann Kåre Slettebakk, Marthe Sondov, Atle Høgberg

Abstract

Implementation of data conferencing collaboration between companies in complex value chains is complicated by issues related to security and compatibility between systems. In this project, a collaborative infrastructure has been established by adding data conferencing capabilities to an existing industrial extranet, making it easier to establish collaboration between member companies. Using this solution, the companies were able to collaborate synchronously through corporate firewalls, with the same functionality as within their own corporate network. The results indicate that using an extranet can be a powerful way of enhancing collaborative performance in dispersed business networks.

Keywords: Collaborative design tools, distributed work, supply chain management, video conferencing, simultaneous engineering

1 Introduction

Engineering design companies delivering products and services to the Norwegian oil industry are facing increasing global competition. As a result, they are currently launching efforts to maintain and improve competitiveness in a global marketplace. The price of a typical product offered, e.g. an oil platform, is determined by the equation below:

$$\text{Price} = \text{Quantity} \times \text{Norm} \times \text{Rate} \quad [€ = \text{quantity} \times \text{time/quantity} \times €/\text{time}] \qquad (1)$$

In equation 1, price is what the end customer pays for the product. Quantity typically describes the size of the project, for instance volume measures, and norm describes the number of working hours necessary to complete a certain quantity. Rate describes the price paid per working hour, including wages, overhead and taxes. Quantity is determined in contractual project specifications, while rate usually is determined by local conditions. In most situations these two (quantity and rate) can therefore be regarded as fixed variables, at least within a specific country.

The norm factor describes the project execution efficiency, and this variable is defined as the most crucial factor to improve global competitiveness. In order to compete effectively with companies from countries outside Europe, where wages can be as low as 50% of standard Norwegian wages or even lower, the norm factor is very important. The norm factor is a complex factor consisting of a number of sub factors, where collaboration is identified as a main component. For the companies involved, the key areas of improvement for the collaborative component of the norm factor are 1) efficient collaboration through document

sharing, 2) project coordination activities, and 3) the capability of making informed decisions at an early stage.

The goal of the project was to implement a collaborative infrastructure for synchronous and asynchronous collaboration adapted to the needs of large, commercial projects with several companies operating in an integrated value chain. This was identified as an approach to improve engineering concurrency and project execution efficiency through enhanced collaborative performance. The project was given the name "Net-Based Project Execution", stating the overall scope of the project. The initiative was launched in January 2001, and the project was completed in May 2002.

A total of 7 project teams of 4-6 members were established. People from Kværner Oil & Gas (currently Aker Kværner Oil & Gas), OilCamp, The Norwegian University of Science and Technology (NTNU) and 4 other companies participated in the project. The other companies included 2 large international corporations, 1 medium-sized supplier and 1 small consulting company.

Kværner Oil and Gas (KOG) is a supplier of new constructions, management, maintenance, modifications and removal of up-stream oil and gas installations in Norway and selected international projects. By collaborating actively with the operating companies, KOG develops technology and products for its customers in partnership with external companies. KOG is Kværner's global knowledge center for large offshore EPCI-projects, and belongs to the Kværner Group (currently Aker Kværner Group). The company is the largest supplier of production facilities for oil and gas fields in the North Sea and has about 6 500 employees in Norway, the UK, the Americas, the Caspian region, the Middle East, and West Africa. Internal KOG projects have revealed a considerable potential for low cost net-based communication and working methods in projects and competence development. These projects have been very successful, showing a huge potential for cost-saving on travel and relocation of 80-90%. By launching Net-Based Project Execution, KOG aimed to scale up and leverage the collaborative methodology from earlier projects to include other companies in the value chain, and obtain similar patterns of cost-reduction, but on a larger scale. The following enablers and success criteria were identified:

- Provide effective motivation for this type of collaboration, and virtual integration of value chains [1] by building suitable mental models that remove some of obstacles to early supplier involvement [2], for instance the tendency to withhold documents until they are ready to be "released" or "published".
- Replace some of the formal documentation routines requiring multiple approvals and signatures, with open communication structures and the ability for all involved partners to get just in time information.
- Provide an infrastructure for communication through corporate firewalls and different companies' security systems, and remove collaboration obstacles related to differences in corporate policy and culture.

The seven teams each focused on different aspects of value chain collaboration in the Norwegian oil industry, ranging from juridical aspects and how to successfully implement new working methods in projects, to technological infrastructure and management challenges for dispersed engineering. This paper describes the results in the *Technology* and *Procurement* teams respectively.

The Technology Team focused on synchronous real time collaboration between intranets by utilizing Internet as a transport medium. The challenges in this context are security during collaborative sessions between individual users engaged in desktop conferencing. The

Procurement Team discussed procurement and sourcing throughout all phases of a project, focusing on identifying phase-specific challenges and problems, limitations in human communication and implications of dispersed, net-based collaboration.

The results presented in this paper cover the areas of establishing a collaborative infrastructure suitable for these organizations, and the process of building organizational support in engineering design companies.

2 Methods

The project was based on the assumption that the oil & gas industry will have to further improve mental models, working methods and tools in order to improve global competitiveness by reducing the norm factor described in the introduction. By testing the collaborative infrastructure and methodology between companies in a small-scaled project, the potential of the proposed approach as well as limitations could be revealed at a low cost and risk.

A main challenge in this project was global collaboration where clients, suppliers and sub suppliers collaborate efficiently on market development, localization, competence and capacity. Although the rate factor (the cost of labor) in Norway is very high, Norwegian companies can compete effectively in a global marketplace by offering complete solutions where knowledge related to technology, product and methodology from all stakeholders involved are integrated into the complete value chain.

In the initial phases of the project, all possible information and communication technologies supporting dispersed collaboration were discussed. Available technologies were placed in one of the following categories [3]: 1) e-mail, 2) teleconferencing, 3) videoconferencing, 4) data conferencing, 5) web-based collaborative tools, 6) proprietary groupware tools, 7) electronic meeting systems. The following collaborative scenarios were subject to further investigation: “Same time, different place” and “different time, different place” [3]. All teams used telephone conferences for audio communication throughout the duration of the project.

2.1 Exploring different collaborative scenarios

“Different time, different place” was the first collaborative scenario to be explored. This scenario was addressed to improve document handling through the implementation of an asynchronous virtual workspace. The goal was to reduce redundant information by providing a single point of access to project data and documents [4]. Furthermore, standardization of working methods across different companies, cultures and corporate policies was identified as a necessity for collaboration between different stakeholders in the value chain. Previous internal projects in KOG and at NTNU indicate that implementing an asynchronous solution for collaboration before starting the implementation of tools for synchronous collaboration is a more robust approach than the reverse order. Hence, starting with the challenges related to asynchronous collaboration was chosen as the preferred approach, as some of the participants were not used to this kind of collaboration across company borders. The chosen provider of technological solutions for this initiative was eRoom Technologies. eRoom acts as a common project web or workspace for asynchronous communication. eRoom was chosen because one of the participating companies already had an installation of this collaborative workspace that was ready for use by all participants.

After exploring the “different time, different place” scenario, the teams moved on to exploring the “same time, different place” scenario, in an attempt to establish an alternative to existing solutions for real time collaboration. This initiative was an effort to reduce the amount of

routine business travel and facilitate more effective coordination of meetings. It was also suggested that this initiative, if implemented successfully, could facilitate on-demand problem solving meetings.

2.2 Efforts, Technology Team

This team focused on technological challenges related to using Microsoft NetMeeting across company borders and through corporate firewalls. NTNU has previously tested the beta version of the Microsoft Exchange Conferencing Server software [4], and the results of these tests were promising for flexible synchronous collaboration over distance and especially for real time application sharing. Currently, most products supporting synchronous real time collaboration over the Internet require open ports through the firewalls. This makes it possible for intruders to get access to corporate intranets. This implies a risk for data to be destroyed or stolen. During the first phase of the project, several technologies were emerging, capable of improving security when communicating trough corporate firewalls. The Technology Team served as a technological advisor on subjects like information technology / information systems policy, security and implementation difficulties.

One of the most prevalent problems was the lack of scalability in current solutions, most notably the non-linear increase in the number of firewall-sensitive connections as the number of participating companies increase. This is shown in table 1 and figure 1.

Table 1. Collaboration complexity using intranet / Internet.

Number of collaborators	1	2	3	4	5	6	7	8	9	10
Number of links	(0)	1	3	6	10	15	21	28	36	45
Firewall-sensitive ports in/out	(0)	2	6	12	20	30	42	56	72	90

Each port opened represents both additional work and a security risk. A company entering a collaborative network with 14 existing members must establish independent 2-way collaboration with every one of them to be able to operate effectively in the network as a whole. Because the workload related to establishing collaboration with a network increases with the size of the network, both in terms of security and in terms of work for the collaborative network as a whole, this represents a self-limiting system. Its self-limiting characteristics reduce the flexibility and make this type of network less attractive. For the companies involved in this project, it was important to reduce the workload related to connecting new partners to the collaborative network.

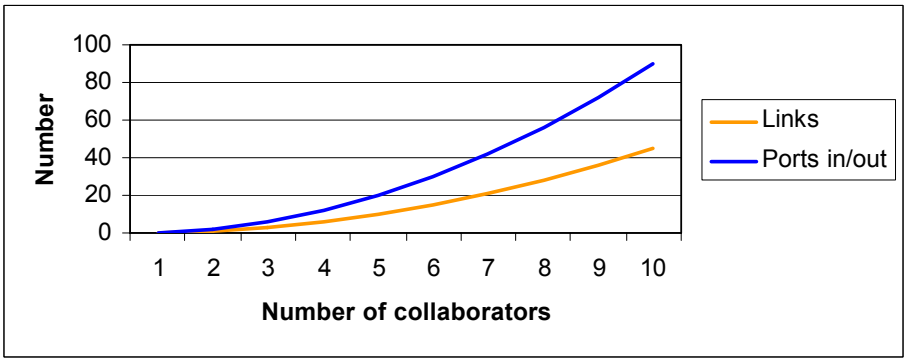

Figure 1. Number of links and firewall-sensitive ports as a function of number of collaborators.

KOG and NTNU had previous positive experience with Microsoft NetMeeting from internal projects, and were interested in exploring the possibility of leveraging this technology

throughout the value chain. However, using the Internet as a real time collaboration medium, added problems related to data security and scalability as described above, which made this technology considerably less attractive. The typical scenario where NetMeeting is feasible within corporate networks, but not possible through corporate firewalls due to security risks, is shown in figure 2.

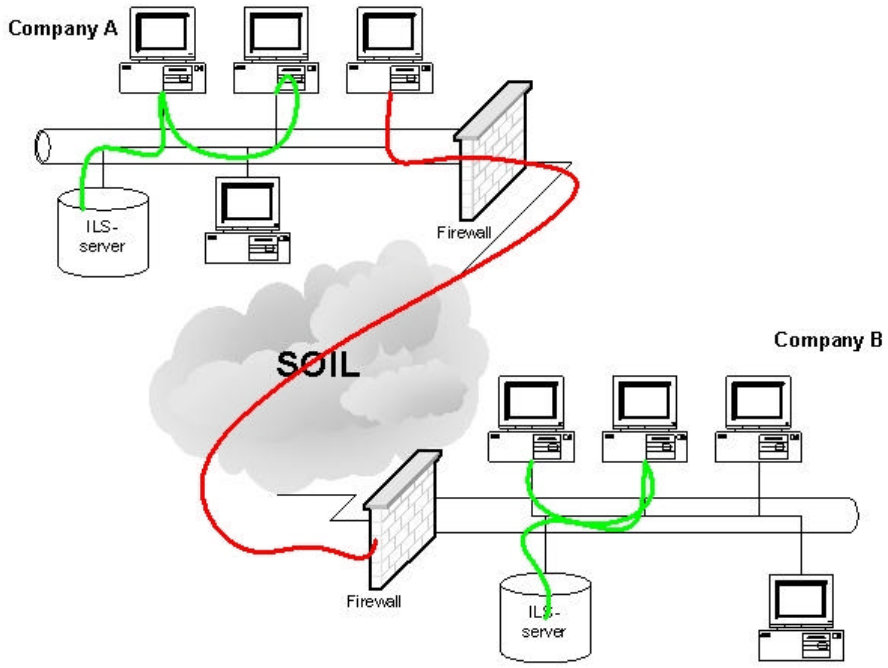

Figure 2. Scenario where corporate firewall restricts NetMeeting collaboration.

After exploring and evaluating available alternatives, an extranet solution was identified as a possible approach capable of maintaining the integrity of the intranets. This approach limits the flexibility and the spontaneity of the synchronous collaboration towards companies that are not connected to the extranet. However, the solution did not represent a major drawback in this case, as most major companies delivering products and services to the Norwegian oil industry are already connected to an existing network, OilCamp's Secure Oil Information Link (SOIL), through membership.

2.3 Efforts, Procurement Team

This team focused on the collaborative challenges related to procurement and sourcing, and its implications of dispersed, net-based collaboration. After discussions, the Procurement Team systematically tested collaborative technologies in the categories teleconferencing, videoconferencing, data conferencing, and web-based collaborative tools. After browsing the market for available solutions that could provide adequate functionality for procurement and sourcing, the web-based collaboration / data conferencing solutions PlaceWare and WebEx were selected for further testing. This technology assessment was done while waiting for a breakthrough in the Technology Team.

3 Results

All involved companies considered the eRoom solution a useful foundation for "different time, different place" collaboration. All project documents were uploaded to the eRoom, and it acted as a reference during the teleconferences that were arranged. Once in place, this asynchronous workspace created an important imperative for further collaboration.

3.1 Results, Technology Team

OilCamp developed the technological solution for the real time collaboration (RTC) initiative, or the "same time different place" collaborative scenario. This was an advanced extranet solution based on Microsoft Exchange Conferencing Server and Microsoft NetMeeting as the client software, and included video conferencing capabilities. Through an iterative process with the participating companies, OilCamp established a central hub, the SOILMeeting server, which eliminates the need for many-to-many firewall openings between member companies. Users communicate with this secured server, and not with each and every client directly. Hence, by opening a single connection with SOILMeeting, any company has simultaneously established a connection with all other companies connected to the server. Thus, the scalability is improved because there is no longer a need to establish individual connections between each company. This is indicated in table 2.

Table 2. Collaboration complexity using extranet.

Number of collaborators	1	2	3	4	5	6	7	8	9	10
Number of links	(1)	2	3	4	5	6	7	8	9	10
Firewall-sensitive ports in/out	(1)	2	3	4	5	6	7	8	9	10

SOILMeeting is a service enabling virtual meetings between SOIL member companies. The users were able to share applications, a common chat-channel, a common whiteboard and file-transfer functions. The booking of meetings and conferences was done through the conferencing server, and the meeting participants could log into the conference through the setup for each company or project member. The final collaborative infrastructure is displayed in figure 3, which displays how the SOILMeeting server represents the connection point for all the participating companies.

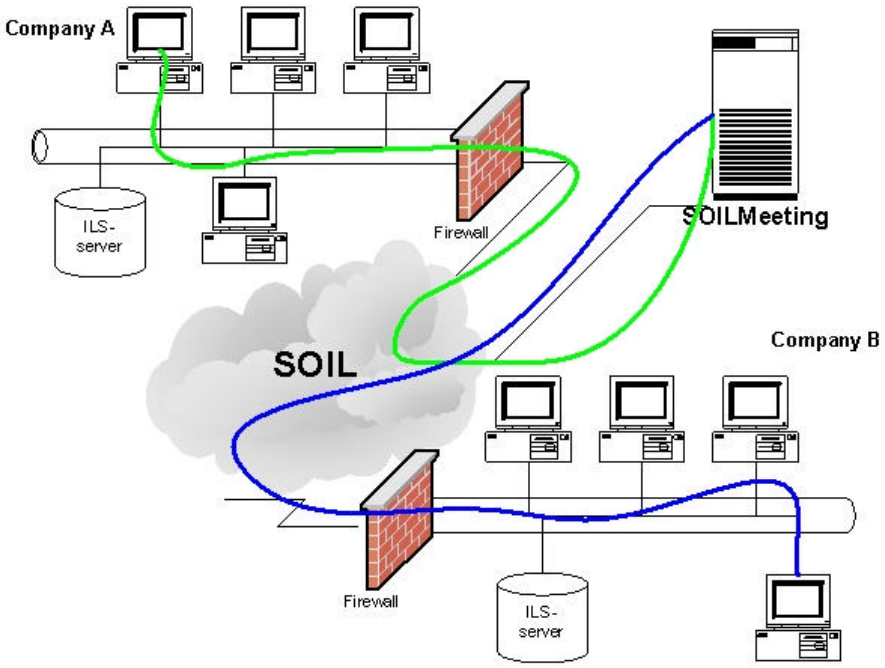

Figure 3. Collaboration using the SOILMeeting server.

It was concluded that an extranet solution provides improved scalability for complex networks, which both improves security and reduces the necessary efforts to establish successful collaboration. For companies not using Microsoft software, the meeting server also supports other data conferencing clients using the T.120 protocol.

3.2 Results, Procurement Team

After collaboration had been established through the use of a combination of telephone conferences and eRoom, the synchronous collaborative tools PlaceWare and WebEx were tested. These tools provided many of the desired qualities, and supported new, innovative working methods, but both tools were perceived as inferior to Microsoft NetMeeting within corporate firewalls. PlaceWare was considered useful as a conferencing tool with limited interaction, as when a message shall be communicated to large groups of people at the same time. However, this functionality did provide adequate support for procurement and sourcing activities. WebEx had many similarities with Microsoft NetMeeting, and as this application is based on the http-protocol, it works through corporate firewalls, which introduces new opportunities for collaboration between companies. At the same time, it was concluded that its pay-per use payment model would slow down the adoption rate in complex value networks. This limited the attractiveness of this technology.

The Procurement Team arranged several data conferences using a combination of SOILMeeting and telephone conferencing. This collaborative tool set provided the necessary functionality for procurement and sourcing, for the first time during it was possible to effectively and efficiently share documents, chat and brainstorm using the whiteboard. Because the team had been working for some time to prepare the collaboration, the work processes typical for procurement and sourcing were easy to implement.

4 Discussion

Of the main challenges that were identified, building suitable mental models and being able to provide motivation for collaboration were identified as two of the most important success criteria. All teams agreed to this notion. In an increasingly competitive, global marketplace, being able to finish a project on time, under budget is rather rare. It was found that contractual agreements and the number of engineering change orders (ECOs) often determine the success of projects. This "contractual trap" has made the industry as a whole very protective, and this has some counterproductive side effects, notably the tendency to withhold documents until they are ready to be "released" or "published". This represents an obstacle to early supplier involvement. Formal documentation routines and procedures typically dominate the communication patterns, which, as a result, favor a linear process. True concurrent engineering, on the other hand, depends on a more open communication structure and the ability for all involved partners to get just in time information.

Through joint discussions and trust-building activities, most of the companies involved opened up their formal documentation routines, facilitating concurrent engineering-type collaboration.

4.1 Technology Team

It was a breakthrough when KOG, OilCamp, NTNU and 3 other companies collaborated synchronously from their own (different) locations. During the project, the project teams successfully implemented a set of new working methods, proving the potential of net-based project execution in the Norwegian oil industry. In order to improve the quality of explicit coordination and reduce information redundancy, OilCamp designed and implemented the first commercial extranet serving these functions, of this size, in Norway. SOILMeeting is a value-added service available to all SOIL member companies. The SOIL network covers most of the Norwegian oil sector, and more than 130 different companies, of which many rank among the biggest employers in Norway.

The emphasis on offering different value-added collaborative services provided a suitable infrastructure for continuous collaboration throughout the development process. The real time collaboration possibilities were tested and found suitable for formal meetings, on-demand discussions and application sharing. Collaboration was tested in a variety of settings, to explore "any time, any place, any setting" functionality. Tests performed with dispersed members collaborating in real time using conferencing software though mobile phone dial-up solutions proved the adaptability of the system for flexible team configurations. In particular, SOILMeeting improved collaboration scalability in complex value chains.

There has been certain bandwidth problems that require further testing, some of these have been solved, others require further testing. Working methods have been identified as a major challenge, as the introduction of new technology must be accompanied by new knowledge and new skills to make the users of the new technology capable of utilizing its full potential.

4.2 Procurement Team

The eRoom technology reduced the e-mail traffic and number of attachments by providing a single source for team documents, which is considered a big advantage for the procurement and sourcing functions. In addition, a document check in / check out procedure ensured that two persons could not make changes in a document at the same time without collaborating and sharing the document with application sharing. This is convenient, as project members can be sure that the documents on the eRoom server are updated with the latest changes.

The SOILMeeting solution opened up new possibilities for synchronous editing of documents. This real time documentation served as a powerful alternative to the time-consuming process of making physical (or digital) notes, editing these and, whenever necessary, review and make changes in the established documentation. Real time collaboration with application sharing made it possible to reduce the number of reviews, and made the decision making process more efficient. However, it is necessary to establish new procedures and contractual agreements that allow these new working methods to be used the way they are intended.

There is a need to establish a better understanding of the balance between synchronous and asynchronous communication, and to make sure there is a close fit between the type of collaboration and the problems at hand. This knowledge can later be integrated into formal project requirements as guidelines for collaboration. Furthermore, new technology expends the possibilities for what can be considered as "internal" processes. This is due to the fact that it is now possible to access and control processes over distance and across organizational boundaries to a much larger extent today than what was the case only a few years ago.

It was concluded that new collaborative methods would change the people working in organizations. While some people will be able to leverage and extend their capabilities using these new collaborative tools and methods, others will feel less at home in the new, emerging organizational structures. It is considered necessary to define new routines and behaviors, and transform these into a new mindset and new working attitudes. Furthermore, the value-adding aspects of traditional, physical meetings [5] were discussed, with emphasis on how these aspects can be transferred, redefined and replaced in net-based collaboration [4].

5 Conclusions

Establishing a business sector extranet was found to be a favorable solution for all involved parties. A more thorough assessment of what constitutes corporate competitiveness is found to be necessary. Moreover, a shift in mentality is needed when new working methods are to be implemented in large projects. Furthermore, there is a need to implement this working methodology in such projects, in order to leverage the potential benefits throughout the network, and verify the scalability of the results found in this study.

The communication solutions that have been tested in this project are powerful enough to have a profound impact on overall business performance. By providing new solutions that transcend traditional boundaries between different companies and organizational units, it is possible to start working on the human aspects of cross-cultural communication and collaboration.

Net-Based Project Execution can thus be viewed as a collaboration enabler making it possible to start approaching these challenges. In addition, other long-term effects of this project include the coupling and streamlining of competence development methods and work activities, as implementation of standardized tools and a stable ICT infrastructure can be used for a variety of inter-organizational and cross-organizational purposes. There are clear indications that such an infrastructure can improve collaborative performance in dispersed engineering design teams.

Finally, embedding the results from this study in best-practice guidelines for collaboration is identified as a key enabler for successful implementation. It was concluded that for future projects, collaborative tools and methods should be embedded in project requirements, making them a part of the formal project guidelines and routines.

Acknowledgements

The authors would like to thank Frank Almli for his valuable contributions to the project and The Federation of Norwegian Manufacturing Industries (TBL) for their financial support, which made this initiative possible.

References

[1] Dell M. and Magretta, J., "The Power of Virtual Integration: An Interview with Dell Computer's Michael Dell", Harvard Business Review, March-April Edition, 1998.

[2] Harbi S., Calvi R. and Le Dain M., "New Product Development and Early Supplier Involvement: A New Supplier Involvement Portfolio", Proceedings of the 8th International Conference on Concurrent Enterprising, Rome, 2002, pp.63-70.

[3] Bajwa D.S., Lewis L.F. and Pervan G., "Adoption of Collaboration Information Technologies in Australian and US Organizations: A Comparative Study", Proceedings of HICSS '03, Hawaii, 2003.

[4] Kristensen K., Hildre H.P., Sivertsen O.I., Fyhn H. and Storler K., "Positioning of Virtual Workspaces in Working Situations for Collaborative Design Teams", Proceedings of NordDesign 2002, Trondheim, 2002, pp.167-174.

[5] Hinds P. and Kiesler S., "Distributed Work. Chapter 5: The (Currently) Unique Advantages of Collocated Work", The MIT Press, Cambridge, 2002.

For more information please contact:

Kjetil Kristensen
The Norwegian University of Science and Technology
Department of Machine Design and Materials Technology
Richard Birkelands vei 2B, N-7491 Trondheim, Norway
Phone: +47 7359 3816 / Fax: +47 7359 4129
kjetil.kristensen@immtek.ntnu.no