Improved Crane Operations and Competence Development in a Community of Practice

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ABSTRACT
This paper describes the lessons learnt in a five year effort to improve health, environment and safety (HES) in crane and lifting operations in the North Sea. We focus in particular on the roles of groupware tools and a crane simulator in skills development of a particular community of practice, and their role in sustaining and improving crane and lifting operations. This work shows the potential of participatory approaches to design in several respects: the combination of action research and ethnography, stakeholder involvement, dialogue in various arenas, development of new work practices and artefacts, and finally, the politics involved in changing existing work practices and the implementation of new approaches to skills development and the improved quality of working life. We describe the context in which groupware tools and simulation training can become integrated in the operating business in order to improve the development of skills and the quality of working life for offshore crane operators, banks men and supply boat crew.

Keywords
Action research, e-learning, groupware, (HES) health, environment and safety, knowledge management, LOTUS DOMINO, simulation training, virtual communities, quality of working life

INTRODUCTION
Communities of practice have become colloquial in the organization development discourse in recent years [1, 2] and a growing number of publications report on the development of web-based communities [3, 4, 5]. However, less is written on the development of Intranet-based communities, meaning that particular groups or communities within organizations (an exception is [6]) with or without management approval develop their own communities (often with new artefacts) to discuss their work practices and sustain further development. One aspect of this issue that is taken up in this paper is participatory design to support skills development of low status occupational communities within organizations.

While the social life of virtual worlds has been given wide attention in CSCW literature [7, 8, 9, 10], interaction and collaboration in computer-based VR simulators have been of less interest to the CSCW community. As a consequence, few publications exist on how Intranet-based communities and VR can be integrated in skills development of particular communities of practices within business organizations. In the literature we see few descriptions of settings in which simulation training is used to improve skills development (education is an exception, see [11, 12] for examples) and the quality of working life for less privileged groups within business organizations. This paper reports on how skills development has been undertaken in crane and lifting operations in Statoil[1]. We focus in particular on the design of a crane simulator and groupware (LOTUS DOMINO), used for skills development, improved quality of working life, and their role in sustaining and improving crane and lifting operations in Statoil. This work shows the potential of participatory approaches to design in several respects. First, the combination of action research and ethnography. Second, stakeholder involvement; third, dialogue in various arenas, fourth, development of new work practices and artefacts, and finally, the politics involved in changing existing work practices and the implementation of new approaches to skills development and the improved quality of working life.

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[1] Statoil is the State oil company in Norway. Primary activities are the exploration of new oil and gas fields, operation and maintenance of a number of offshore oil and gas production installations, operation and maintenance of refineries, transportation, marketing and distribution of intermediate and end products.

Statoil has used numerous means and methods to decrease the level of unwanted occurrences in crane and lifting operations (from now on called C&L O) on its offshore installations since the mid 1990s. A long-term skills development process for crane operators has been undertaken, together with additional corporate work processes and campaigns that should further enhance work with health, environment and safety (HES). The aim of this paper is to present how groupware and simulation training can be employed in skills development, to sustain and further increase HES in the offshore operation of cranes. The research question is as follows: How can groupware and simulation training improve the skills development and the quality of working life for the existing C&L O offshore community? We focus in particular on the role of a partly virtual crane and lifting community that reflect on and improve their operational practice.

The content of the paper is as follows. We start by describing key elements of crane operations in the North Sea. Then we describe the improvement of crane operations mostly from the perspective of crane operators. After this short presentation we focus the description on the development of a partly virtual community that handles skills development by groupware and simulation training. The groupware applications and crane simulation environment that have been developed are described. Finally, we try to describe some preliminary lessons learnt in a project that is not finished.

CRANE OPERATIONS IN THE NORTH SEA

All types of supplies and cargo to offshore installations in the North Sea are transported to the continental shelf by supply boats. These boats call at installations every day or at regular sailing intervals. A typical year for Statoil has some 6600 vessel landings with more than 300 000 tonnes of outgoing deck cargo and 700 000 tonnes of bulk supplies. The cargo is lifted on board the installations using fixed cranes. On older installations the distance from the surface of the sea to the deck on the installation can be 75-90 metres. Each platform has dedicated crane operators and banks men with the responsibility to take care of the transport from the boat to the deck of the installation, see Figure 1. In addition to this they conduct all internal transport on the installation. As a consequence, crane operations are vital for the daily operation of an oil installation, for lifting up spare parts, piping and drilling equipment, bulk and food. Statoil operates around 50 offshore cranes and a community of 400 crane operators and banks men are directly involved in C&L O. In addition, there are those working in the supply boats owned by the shipping companies that operate on the Norwegian Continental Shelf.

C&L O are high-risk activities for a number of reasons. First, stropped cargo and containers that weight up to 30 tonnes must be handled often with poor visibility during harsh weather conditions and can include operations at night. Also, there can be fog, heavy wind and high waves. Second, new installations are mainly floating (anchored to the seabed), meaning that crane operations have to take into consideration the movement pattern of the installation. As a consequence, new floating installations bring new operational demands. This means new requirements for the skills of the personnel (on the installations and supply boats), and crane and lifting equipment. Third, there is a potential risk for supply boat crew and banks men of getting squeezed between cargo containers, or hit by falling objects. The coordination between crane operators, banks men on the offshore deck and seamen on the supply boat deck is of great importance for safe operations. Finally, the effort related to improve skills development and status for C&L O is not related to improved safety alone. It is also increasingly related to the development of flatter and team-based organizations in Statoil. These new work designs give much more responsibility to the individual. However, they also set tougher demands on people's skills and lead to more autonomous interaction across technical disciplines and functional borders.

Figure 1. Crane operations on the "real" Gullfaks installation. Photo by Marit Hommedal, The Poseidon Magazine of Statoil

The first rule of crane operation is communication, and the crane operator uses communication to tie various material elements together. If one element fails he is able to use other elements to reconstruct the situation. Let us look at these elements. During operations crane operators rely of eyesight and a set of visible signs that indicate various types of action. A standardized sign language is used for standard situations: lifting the cargo, stop and release the cargo. In addition, they are dependent on the other physical movements of banks men and supply boat deck crew (i.e. walking towards or away from a container). A skilled crane operator is able to see if the latter is a novice and be extra cautious. Shadows are a key element in the interpretation of the position of the cargo. When the crane operator sees the shadow of the cargo because of sunlight or artificial light on the deck, he knows the position of the cargo in relation to the deck. During C&L O a UHF radio is used to communicate with the deck of the installation and the supply boat crew. A multiple communication is another issue and the crane operator is also in direct contact with the bridge of the supply boat if an emergency situation develops. UHF-radio is the main communication device, both for planning (job preparation for potential HES hazards: dangerous goods and discussion between crane-supply boat), and executing the C&L O (direct the overall unloading or loading operation). In addition, the dashboard inside the cabin indicates the state of the crane itself: how much wire is out, the weight of the cargo and the dynamics of the cargo. They use the wind gauge to see the direction and strength of the wind. There is often a video camera on the tip of the boom of the crane that can give an overall perspective of the location of the cargo in relation to the boat deck. A skilled crane operator is able to read the exact location of the crane in relation to the installation or boat deck. These skills are acquired by experience. In special situations like operations in blind zones, the use of flagmen is compulsory, and these direct the crane operator using both hand signals and UHF radio. A standard telephone is used in the crane operator's communication with other parts of the installation. Very few cranes have PC-networks yet and it is difficult to see that more computer support can improve the robustness of the current communication system. However, computer systems for planning C&L O are on its way, through development of logistic systems that can tell the crane operator the estimated arrival time of the supply boat, the content and placement of the cargo, handle cargo manifests and make it possible for him to enter return goods. However, such systems are not designed to handle the situation of every unique loading and unloading experience and will mainly be one among many resources for C&L O.

Crane operators and banks men, those involved in C&L O, are one of the occupational communities in Statoil with the lowest formal education. Many are traditionally recruited from the merchant marine, and are former seamen. As a consequence, their experience is considerable. At the same time they do the most high-risk offshore activities: for the whole Norwegian Continental shelf (Statoil included). The Norwegian Petroleum Authorities reports that the frequency of these unwanted occurrences were around three a day in the period of 1994-1999.

Experience related to crane operations both on the Norwegian and British Continental Shelf show that most of the occurrences, in the final instance are related to human factors. The direct and indirect reasons for these occurrences have been improper use of machines and tools, wrong procedures for loading/unloading cargo, lack of knowledge of proper procedures for C&L O (often failure in communication), lack of skills and lack of motivation. These are all traits of an unsafe operational and maintenance culture. High-risk industries with an unsafe maintenance culture often have the following traits: components and technical systems like cranes, are run over long periods of time with known weaknesses, or run outside their specified operational and constructed requirements. The two latter

phenomena are in most cases related to the work practices of the people on board an installation and comprise a shared and collective weakness. These phenomena exist because the personnel accept that known weaknesses exist on the installation, and that the proper balance between production, profit and HES has not been properly discussed and handled. This weakness is often related to a choice of values; profit vs. safety, i.e. that production is more important than HES. As a consequence, collective decisions are taken that are in conflict with the prevailing safety instructions.

Examples show that crane operations can become a bottleneck, when operations or drilling need new spare parts to keep the oil production up and running. The shut down of an oil installation is very expensive. Such expectations have sometimes led crane operators to operate the crane under questionable weather conditions, i.e. where the wind is over 40 knots. Reported occurrences indicate that accidents occur between different groups: installation deck personnel, the crane operator and the supply boat personnel. These groups have different occupational cultures and dangerous situations can develop during high activity periods. Experiences from concrete or steel seabed installations make the main experience basis (equipment, routines) for Statoil crane operations. New concepts like production ships and floaters require new work routines. In conjunction with this is the increase in the general activity level and effectiveness of operations offshore. The logistics related to supplies in the North Sea have been adjusted to "just in time" principles. Sailing intervals are optimized, and supply boat cargo space is utilized more. The time supply boats spend on each installation is reduced, and an increased activity level makes it more stressful to unload and bad supply boats. As a consequence, planning and executing C&L O is more complicated than it used to be. Maintaining a proper safety level places tougher demands on managing, executing activities and employing the skills of those working in this domain.

C&L O has traditionally been a dead end for further career development, something that also coincides with the lack of formal education. To improve the quality of working life and develop meaningfulness in their work many crane operators have become trade union representatives. Very few crane operators have moved up the hierarchy to become middle managers or received more senior positions on the installations. The consequence of all this is that few in management know how skilled top crane operators can be. Lucy Suchman [13] has convincingly argued, that work has a tendency to disappear at a distance such that the further we are removed from the work of others, the more simplified and stereotyped our view of their work becomes. The consequence related to C&L O, until recently, is that what is regarded as "simple" and stereotyped is not regarded as important.

In the development of communities of practice, the existence of arenas where the community can come together, discuss and reflect upon their action is of great importance [1, 2]. Such situations or arenas do not always exist for crane operators. Crane operators are often located in their cranes. They do not necessarily have continuous contact and dialogue with other crane operator colleagues. They work 12-hour shifts, 14 days at a time and then have three weeks off. On newer installations there might be two crane operators. When one is sleeping, the other is working. On the new team-based floating installations like Norne and Aasgard, the crane operator has a part-time position. Due to long intervals between supply boat arrivals crane operators also work as mechanics. This can create additional strain. Onshore periods off make meetings and discussions difficult since crane and lifting personnel live in different parts of Norway. People involved in C&L O have traditionally lacked a community of practice across installations and shifts and the need to come together and discuss their work has not always been sanctioned by management. During the last five years a technical engineering support unit onshore has provided continuity in C&L O expertise. An operational representative, a crane operator in a yearly rotating position has filled an important role as co-ordinator in this core group. This operational representative has both the internal credibility and expertise to function as a liaison between the many offshore installations and the onshore core group. Since 1995 this C&L O onshore support group has arranged a yearly seminar for onshore crane and lifting personnel where overall crane and lifting issues are discussed, and where all installations report on the situation at each installation.

To conclude this section, within C&L O a number of efforts and improvement projects have been undertaken since the mid 1990s to improve safe operations: cultivation of HES values, training and skills development. These projects have set up some mechanisms to sustain and improve safe C&L O. Statoil's vision is to be in the front with relation to HES issues, and the espoused target is zero damage. Could groupware and crane simulation provide additional mechanisms to develop arenas where the C&L O community could meet face to face or virtually to reflect upon present work practice and discuss how future efforts could be undertaken to improve HES in the crane and lifting domain?

THE DEVELOPMENT OF A GROUPWARE TOOL TO SUPPORT THE C&L COMMUNITY IN THEIR DEVELOPMENT AND IMPROVEMENT OF "BEST PRACTICE"

Statoil operates around 50 cranes on 15 installations. Much C&L O is dependent on crane construction, installation type and the local culture of the installation. In the effort of improving C&L O the need to develop joint practice across installations was discussed among the crane operators themselves. They saw that it might be impossible to standardize this practice due to various crane and lifting conditions and situations on Statoil's 15 installations. Still, there were several reasons for wanting to develop such a "best practice." First, crane operators wanted a thorough discussion on the borders or limits of operations. This is the line of operations as usual and "no go" (stop C&L O of various conditions like weather, visibility, and sea conditions). In order to handle expectations in their daily work, from middle management and colleagues, they wanted more detailed guidelines to legitimate a "no go". For instance, a 40 knot wind is "no go," no matter how urgent the unloading operation is for continued operation. Crane operations must stop at 6 metre-high waves. Experience indicates 3-3.5 metres are problematic on floating installations. Second, if Statoil was to improve crane operations, there had to be a number of features of a common practice across the community. The development of this common practice could be a way to create a collective reflection process among the 400 crane operators and banks men in Statoil. Third, a number of representative situations were needed for the crane simulation exercises. A proper involvement of the community was believed to be a future investment in the use of the simulator, see next section.

A project group/task force with offshore crane operators and the onshore crane and lifting technical support was set up. Statoil Research and Technology provided process support and groupware prototyping skills. The task force were 10-15 people depending on the C&L issues to be discussed in that particular session. All Statoil installations were involved either directly in the task force or indirectly through a support group assembled at regular intervals. In a number of workshop sessions the crane operators of the task force defined core elements of this "best practice" based on their long offshore experience. Stakeholders from drilling, marine operations and shipping companies were also involved in this process, since they were directly or indirectly involved in C&L O. A groupware application was developed to support this reflection and involvement process, a redesign of simple LOTUS NOTES application used offshore since 1996-97 [14]. The design process closely coincided with a cooperative and constructive design philosophy with cyclic prototyping [15] and participatory design [16][2]. This LOTUS DOMINO bulletin board was set up more or less at the same time that the work with the "best practice" had started. The latter evolved into an arena that enabled the task force to work with their task force assignments in their spare time on the installation or at home. Since all Statoil employees have PC's with ISDN Internet accounts at home it was also possible to work with their assignments during their spare time. The project wanted to create a channel for communication where crane operators and banks men could discuss their operational practice. This bulletin board could be reached both via the Statoil LOTUS NOTES infrastructure and via a web browser. The bulletin board was a new feature that had been practically impossible in the past, where much dialogue between crane operators had been going on by e-mail or telephone. The only official arena in the past was the yearly crane and lifting seminar.

The task force spent considerable time in discussing the values of the work practice via search conference (Greenwood & Levin 1998) seminars in December 1999 and January 2000. These seminars discussed: what is required to further improve safety in C&L O with given safety targets, what are the elements of a safety culture, how do we communicate with those involved in crane and lifting operations and what are the skills and demands expected from those working in this domain? This discussion and reflection on values formed the basis for the espoused practice that was written down in the winter and spring of 2000. The written and explicit practice did not describe in detail how crane and lifting should be conducted. The situated practices of different installations would have made this impossible. Instead it included tips on important issues, how to maintain the crane, prepare and execute crane operations, how to handle critical situations, how to load cargo with what straps, how to communicate during crane and lifting operations, provide guidelines for special lifts, the transport of persons and internal transport on the

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[2] The overall methodology employed here was action research [17]: on site and participant observation of crane and lifting operations, facilitation, informal discussions with participants in the process from the latter part of 1999 and through out 2000 process support in crane community "best practice" workshops in 2000-01 and participation in VR crane simulation sessions. All in all, the action researcher was a "friendly outsider" vis-a-vis the C&L community, that conducted on-site observation, facilitated discussion and reflection sessions in the community and developed a LOTUS DOMINO bulletin board inspired groupware application.

installation. Examples of formulations related to C&L O preparations:

"All lifting operations are high risk. A good practice for each person is to think through the whole lifting operation and evaluate if all necessary efforts for safe operations are taken".

"Everybody involved in the loading/unloading operation must be equipped with UHF communication equipment that have a headset and an integrated microphone"

"A safe zone must be defined before the operations start"

"Personnel on the supply boat must not leave the safe area before being given a "go" signal by the crane operator"

These representations are multiple and ambiguous in character, meaning that the "best practice" formulations are indexical (Suchman 1987:61). The significance of the "best practice" formulations is not found in the formulations themselves. The crane operator must find the "best practice" useful in particular situations. Even though the formulations themselves were regarded as important, the task force considered it more important to create a common methodology, and a language for continuous improvement and creating a setting in which crane and lifting operations could become systematically discussed in a community of peers. The aim was to "keep the conversation going," meaning reflection and action as a continuous activity.

In the winter and spring of 2000 new functionality were added to the LOTUS DOMINO bulletin board through cyclic improvements. The application was available on the Statoil IT infrastructure. Interested personnel could see the day-to-day progress in the task force. Those interested could make comments on the formulations using real names or be anonymous. In a community with low levels of education writing can be problematic. In some cases the project approached the proposal(s) and discussed the proposal via telephone. All improvement comments were answered whether these were rejected or implemented and the argumentation behind the rejection/implementation decision was written on the improvement comment. As a consequence, the status of the comment could be tracked at any time. The overall functionality of the application included:

- The application contained a fully text indexed searchable description of main aspects of a "best practice" for C&L O in text and rich pictures. It is decomposed from overall issues like HES, via values of a safety culture to larger details like crane maintenance and hints on the change of a crane wire. All descriptions were DOMINO documents
- The ability to write improvement comments to any of the documents
- A specific view for tracking and handling improvement comments sorted as: under processing, rejected or implemented in the "best practice." Additional sorting mechanisms listed the installation name or organization unit
- Links to overall Statoil and government regulations of C&L O

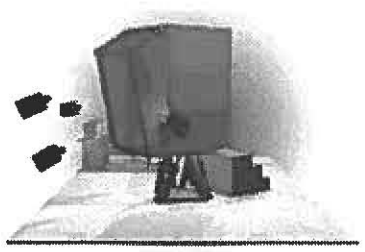

Figure 2. The hiCranesimulatorTM with movement platform, projectors and instructor station

An involvement of major stakeholders was undertaken throughout the process. Through the task force the project had access to important nodes in the informal network of crane operators and banks men. The unions supported the activities, and the project had a steering committee of people with high credibility. A number of meetings were set up with Statoil senior management to report on the development of the "best practice." A large workshop with offshore middle managers was held in April 2000. This meeting discussed the implementation of the new practice on all Statoil installations. In addition, to keep the work alive, core members of the task force visited all Statoil installations to present the new best practice in C&L and meet middle management and those working in C&L O in face-to-face dialogue.

THE DEVELOPMENT OF A CRANE SIMULATOR TO IMPROVE HEALTH, ENVIRONMENT AND SAFETY IN RELATION TO CRANE OPERATIONS

The idea that a crane simulator could improve HES and skills development in C&L O came from two crane operator opinion leaders. They visited a crane simulator is the US and wrote a report that supported the development of such a simulator in Statoil. A feasibility study was undertaken, a requirements specification was made and a project was set up with the necessary budget provided by Statoil general management. A project with Statoil and two additional

parties were set up. HITEC Vision and their subsidiary HITEC O[3] got the contract of building the simulator now called hiCranesimulatorTM. The rest of the simulator facilities, courses and the daily operations were to be arranged by SMS[4] in Trondheim, with the help of two Statoil crane operator instructors. Major elements in the "best practice" should be used to develop training situations in the crane simulator. Even though simulation training never can replace everyday operations there were several reasons to believe that simulator training could improve HES in relation to crane operations. Major aspects of the crane's manoeuvrability, movement patterns, dynamics, speed, time delays, weather, visibility, and load can be simulated in a virtual environment. Crane operators cannot rehearse critical situations offshore because of the safety issues this involves both for equipment and personnel. A large number of Statoil crane operators have worked on traditional fixed installations. When they move to the new floating installations they have to learn to handle these new movement patterns. Many of these new operating conditions can be simulated giving crane operators some early wins in their training and mastering the new situation. The idea is to improve the skills of the crane operators and banks men by going through a number of training situations, like emergency situations and emergency preparedness. They receive feedback on their performance and problematic operating conditions can be repeated until the wanted practice is developed. Everybody involved in C&L O in Statoil will have to participate in these courses every second year. Various courses are made for different types of personnel. Courses include crane simulation for banks men, basic or advanced training for crane operators, repetition courses and co-training with supply boat crew and tailored courses for personnel with special needs, like middle management and technical personnel. All courses combine theory related to C&L O and practical simulation exercises. The simulation exercises start with a briefing (describe the exercise and what is to be done), then proceed through simulation training and end with a debriefing together with a group of crane operator peers, banks men or supply boat crew. Experienced crane operators from Statoil are instructors during simulation exercises. An e-learning home page on the Statoil Intranet has been developed to prepare offshore personnel for crane simulation. This homepage contains the compulsory preparations for the simulation training, including a presentation of the simulator facility, the content of the exercises and its learning model. Links to "best practice" and crane resources on the WWW are also available.

Figure 3. Simulation exercise. Moving a container on the virtual Gullfaks installation. Photo by SMS

The physical elements of the crane simulator are as follows (see Figure 2 and 3). The crane cabin is a replica of equipment used on numerous installations. This crane cabin is placed on a movement platform that can be adjusted to the movement patterns of Statoil's installation types. Projectors visualize the world outside the crane. The simulation or visualization system is run on WINDOWS NT (developed through MACROMEDIA AUTHOR-WARE and 3D STUDIO MAX). The crane simulator software projects images covering the total eyesight of the crane operator, projecting pictures via a front window, two side windows and a roof window. This virtual environment incorporates the physical structures of Statoil's fixed and floating installation types and a number of supply vessels. A number of parameters can be set to manipulate the environment. Simulation software controls the simulator and the instructor manipulates the simulator through three instructor PCs and a TV monitor. Two PCs are used for feeding parameters (different scenarios like installation type and crane type, wind, waves, light, visibility, load type, weight) into the simulator. This means that the instructor can use one machine and peer simulation course participants, the other A third PC gives the instructor a graphical window of the operation from different positions. A TV monitor makes it possible to see what is going on

[3] HitecO is a Norwegian company developing products for presentation, training, simulation and visual tools for optimalisation of man-machine interfaces. Homepage http://www.hitec-o.com/

[4] SMS is the ship manoeuvring simulation centre in Trondheim that offers many tailor-made courses within ship handling and maritime management. Homepage: http://www.smsc.no/index.php3

inside the crane cabin. The instructor has radio and telephone communication with the crane operator. An audio system for simulation of familiar sounds in crane operations and a simulation programme for different crane types using different cargo carriers is also included. Additional collaborative features of a virtual environment are achieved by integrating the SMS supply boat simulator with the crane simulator. The supply boat and installation crew can coordinate each other's manoeuvres during real-time exercises in the virtual environment. In the debriefings the deck and bridge crew of the supply boat come together with the crane operator and banks men to discuss their mutual simulation exercises. The courses are planned so that those taking the exercises work on the same part of the Norwegian Continental Shelf. This means that supply boat personnel and crane operators may have talked to each other via radio before or might meet in future situations.

IMPROVED CRANE OPERATIONS, LESSONS LEARNT

The long-term target of improved crane and lifting operations is the development of a robust safety culture, of which groupware and simulation training already have proved to be of some significance. The introduction of groupware and simulation training came rather late in the five-year efforts to improve HES in crane and lifting operations. In January 2002 Statoil and SMS have over a year's experience with the crane simulation and the "best practice". The deceasing number of unwanted occurrences in C&L O in Statoil operated installations in 2000-2001 can increasingly be connected to the use of simulation training. In 2001, Statoil has had two unwanted occurrences where the crane came out of control due to a technical malfunction. The accident reports conclude that simulation training was instrumental in minimizing the consequences of the accidents, because of crane operators improved skills in handling emergency stops and critical situations. It remains to be seen if the good trend will continue and it is too early to draw definite conclusions in these matters. In spite of this we want to address some of the lessons learnt in the light of participatory design practices.

First, the groupware application based on LOTUS DOMINO has become an important arena where those involved in the C&L O community can discuss their work practices and find useful hints about everyday practices. This application also functions as a repository both for crane operators and banks men in addition to those indirectly involved in crane operations: the supply base, drilling and middle management. In this sense it is becoming a collaborative artefact that ties together C&L O practitioners from different installations. At the same time it is opening the borders to other offshore communities: drilling, marine logistics & operations and supply boats. We see that the groupware tool made in conjunction with the development of the "best practice" made it possible to maximize the autonomy and communication between different installations of crane operators and along the borders to other communities of practice in marine operations. It enabled the different social worlds that participated in the project to maintain a large portion of autonomy in the daily work. Only given parts of the work practices were pooled in the intersection of information outside the crane lifting community, the rest could be left alone. Drilling could use what they needed and so could the Statoil supply base personnel. We have received requests from oil and shipping companies that want to buy the content of the "best practice". Up till now we have turned these requests down for two major reasons. It will make little sense passing over static texts to people in other companies that have not been involved in developing them. We argue that it is the methodology and the involvement process that is unique. It is this process the companies need to recreate in order to develop their own interpretations of the best practice. The "best practice" texts are of less value without the latter and ought to be developed as a part of a long-term reflection in action process.

Second, the work with the best practice and the long-term skills development have taken up the challenge of Lucy Suchman [13] in making the C&L O community more visible in relation to other operational activities. The cynic might say that externalization of work practices have made the crane and lifting community more vulnerable to management intervention. Still, this argumentation is too simple. Our process has demonstrated that crane operators in particular have a peak competence that cannot be ignored. It has also shown the importance of crane operations in relation to other activities since the crane operator is an obligatory passage point for all shipments and lifting activities on the installations. As a consequence, the work with the "best practice" has given the community more self-confidence. In the end this means better ways of handling expectations from drilling and management and has made crane operators, drilling and middle management more reflexive related to "no go" or borderline situations.

Third, as a consequence of the above, the process has led to more openness both within the C&L community and marine operations. The climate for discussing the proper values of a safety culture, its elements in terms of work practices and skills demands have improved.

Fourth, this work has increased the focus on the need for improved education and training within the crane and lifting community. Statoil has lobbied strongly for the development of certificates for apprenticeship in crane and lifting operations. The training model combining

discussions of "best practice" with practical operations seems to be a promising way of "standardizing" operational practice and building a foundation for a stronger safety culture through sharing of experience. The Norwegian government is now taking efforts to improve crane training on the whole Norwegian Continental Shelf and developing a specific education in this domain (starting in autumn 2002). These efforts along with new legislation will help to increase the general level of the quality of working life for those working in this domain.

Fifth, the high degree of mobilization that this project has developed in the Statoil organization shows the tiresome process such projects have to go through. This form of skills development is much more than creating e-learning portals and sending personnel to external courses. From day one this project has been a grassroot movement and its career has been connected to the actual skills development needs of the crane and lifting community. The crane and lifting personnel have taken responsibility for their own learning process. The project's success up till now lies in tying together small almost invisible activities and tedious details. Management support has been important but has hardly been enough. The challenge is still to persuade more middle managers and technical personnel to take the introductory crane course. If the groupware application is to remain a catalyst in the improvement of a "best practice" it is dependent upon the continuity of the task force and an informal network of supporters on all Statoil installations.

Sixth, we have used a cultivation approach instead of a re-engineering approach in improving crane operations. Cultivation is a less radical form of change that builds on the existing culture and work practices of Statoil operations. It acknowledges that much is good and can be further cultivated. However, it also acknowledges that change is difficult and acknowledges how original intentions often grow or drift into something else [19]. Cultivation lowers the level of ambition compared to more traditional change processes. Knowledge and skills development processes like the improved crane operation initiative acknowledge that such knowledge processes cannot be engineered. Our way of handling this approach was not necessarily to focus less on plans and targets, but to incorporate the need to seize and be open to opportunities that drift along.

Finally, the "best practice" groupware application is now built around a continuous improvement effort of HES in the crane and lifting domain. It is part of a general methodology for continuous improvement that involves all offshore installations in Statoil and is becoming institutionalized in most settings that deal with crane and lifting operations in Statoil. "Best practice" in crane operations is only viable when it is dynamic. The task force and representatives from various installations that developed the best practice continue to meet two times every year to process C&L O improvement proposals, and decide if they are to be included in the "best practice" or not. They are still key nodes in a community of practice, a position that is also strengthened by the some members' trade union positions. Logged user activities of the "best practice" application in December 2001 indicate that the two replicated DOMINO databases had over 100 hits/accesses every day. This is a considerable amount of hits for the C&L community of 400 that work in three 14-day shifts. Close to a hundred improvement proposals in the "best practice" DOMINO bulletin board have been processed by the task force in 2000 and 2001, related to formulations in the "best practice." This is promising and indicates that it is taken up and become a part of the community. The HES statistics indicate that the rate of injuries and incidents in crane and lifting operations had a historical low level in 2000 and has continued to drop in 2001. The crane simulation courses have been up and running since February 2001. All courses became quickly booked for 2001. Some 200 persons from Statoil's production installations and supply vessels have gone through simulator training in 2001. (In addition approximately 100 persons from other companies have used the simulator in the same period). The response from the operating personnel has been very positive indicated by the fact that almost all of Statoil's available courses were fully booked during the first year in operation. By January 2002 The Shipmanouvering Simulator Center had received bookings for 2002 for close to 650 persons from different companies operating on the Norwegian Continental Shelf.

It has taken some time to get the training up and running smoothly. There have been some technical problems with the software especially after each new update of the simulation software. Most crane operators tell that it is different from operating a crane in the North Sea, the lack of depth (i.e. how far away is the supply boat deck?) in the virtual environment is a challenge. They still report that it is a good thing to rehearse on situations that are impossible to do offshore. The improved self-confidence in the C&L O community cannot be ignored: not only plane pilots have simulation training, crane operators also. However, the most important lessons so far happen during co-training between crane operators and the boat crew. When the co-training courses between Statoil C&L O and supply boats were developed, major Norwegian supply boat shipping companies were keen on taking part in this process with personnel from both the deck and the bridge. The offshore installation community and the shipping community have stereotyped notions of each other. When discussing the everyday work practices from the setting of each "life world" in the courses (a process that started in the development of the co-training courses and continues in the

courses), the crane operators experience that what the seamen argue makes very much sense and opens up new perspectives. Out of these discussions a respect for each other's skills can grow that is further cultivated in the co-training sessions between supply vessel- installation. Efforts are taken to run crane simulation courses with people from the same installations. In the co-training sessions with supply boat crew crane operators and banks men collaborate with sailors and navigators onboard ships that traffic the same part of the Norwegian Continental Shelf. In the long run we believe that this will have a positive effect on the daily collaboration and communication between all groups taking part in crane and lifting operations on the Norwegian continental shelf.

Further work with the groupware application and the crane simulator

The major challenge is to keep the work alive in a situation where a number of other company improvement efforts compete for attention and resources. Management support is important but hardly enough. If the groupware application is to remain a catalyst in the improvement of a "best practice" it is dependent upon the continuity of the task force and an informal network of supporters on all Statoil installations. It requires a dynamic process to keep it alive, where IT-support (in the form of IT system maintenance, extranet distribution of the database and CDs to rigs and ships with no Internet connection) is just one aspect. A number of initiatives have been undertaken to align the work with existing organizational institutions and improvement work in general. The improvement work in C&L O has also been aligned with the improvement of marine operations (supply services, anchor handling and towing), developing systems and work practices in marine operations more in general. The community has discussed if more collaborative functionality for virtual meetings should be included in the bulletin board. Mobile PDA solutions of the "best practice" are possible options if they have EX certificates. Awareness mechanisms and chat-like functionality are other candidates. The development of broad bandwidth computer networks will make it easier to implement computer-supported multimedia training exercises and visualizations. Online training through a simplified crane simulator has also been discussed as an additional feature, since simulation time is expensive. Finally, an enlargement of the community is discussed, incorporating more of the community of marine operations. These include supply boats, drilling and the supply bases of Statoil. The groupware application is part of the Statoil Extranet (via a Marine Portal) and is accessible free of charge to all our vendors and collaborators that are involved in crane and lifting operations directly or indirectly.

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