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ConocoPhillips Onshore Drilling Centre in Norway—A Virtual Tour of the Centre Including a Link Up With Offshore

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Abstract

Integrated Operations can be defined as using information technology opportunities to change work processes to achieve better decisions, to remotely control equipment and related processes, and to move functions and operations personnel onshore as stated in the Norwegian White Paper, number 38, 2002 (St.meld. nr. 38, 2001-2002, Ministry of Oil and Energy)

Integrated Operations are often characterized by operational concepts where new information and communication technologies are used in real time to optimize offshore oil and gas exploration and production resources. This enables large volumes of data to be measured, sent to users via high bandwidth computer links that are shared amongst a broader user audience, and data that can be used to form better decisions.

Integrated Operations cover all aspects of business activities from Exploration to Drilling to Production though this discussion will focus on the Drilling aspects. For ConocoPhillips Norway (COPNo.) to employ this technology there has been a need to re-organize operations, to investigate new work processes and a need to establish a willingness to share information.

According to a study by the Cambridge Energy Research Associates in 2003[1], the increased use of new and emerging digital technologies could potentially boost world oil reserves by 125 billion barrels over the next 5 years. Petoro A.S. of Norway has estimated the added value of applying *e*Field and Integrated Operations (IO) on the Norwegian Continental Shelf to be NOK 150 billion[2]. A more recent report by the OLF (Norwegian Oil Industry Association) indicates that the value of IO to Norway could be NOK 250 billion[3]. In summary, industry studies indicate that the potential benefits of IO are significant.

Five key digital technologies will substantially improve the oil industry's ability to see reserves more clearly, plan optimal drilling and production strategies and manage operations more efficiently. They are:

a. Remote sensing
b. Visualization
c. Intelligent drilling and completions
d. Automation, and
e. Data integration.

This paper outlines the industry-leading experiences of the COPNo. drilling and well service group over the last 5 years from field-wide Integrated Operations.

Integrated Work Process Developments

The integration processes are best expressed in the chart shown in Figure 1. The industry sees the following development scenario for IO[4] where the Generation 2 processes develop as a result of more integration not only internally, but externally with the Operator's service providers.

The Onshore Drilling Centre and Offshore Integrated Systems

The Onshore Drilling Centre (ODC) at the COPNo. offices in Stavanger, Norway, consists of a group of inter-related operations rooms.

The centre was initially established with a large operations room as can be seen to the lower right in the picture in Figure 2. Large wall screens display drilling parameters such as depth, bit weight, string torque, gas levels, mud weight and volume information. Geological formation information can also be displayed, including real-time visualisation and the recent addition of a high-resolution digital microscope offshore, to help in the decision making process. Closed Circuit TV (CCTV) is also available from the offshore operations. The operation room supports all COPNo. drilling facilities in Norway, and potentially can offer support for other areas of operation. Operational geologists, Measurement Whilst Drilling (MWD), data or logging

engineers, Drilling Optimisation engineers, Directional Drillers, plus others, work remotely from the operations room which is about 280 kms from the drilling facilities offshore.

The large central room is primarily for collaboration and video-conference meetings with offshore operations and external parties. The communications systems have been set up to enable a single morning video conference meeting with all 4 - 6 offshore operations, the drilling contractors and other service providers, which ensures that all onshore and offshore operations are up-dated with a high level operations overview within a 30 minute meeting period.

There is a large 3-dimensional (3-D) visualization room to the left of the picture in Figure 2. The visualization facility enables a 3-D view of the field area and reservoirs, with any number of selected wells showing. The full Hi-Definition display (2486x1050 pixels) also allows multiple sources to be displayed at one time, such as PC, Linux, Solaris and video conferencing. This allows improved collaboration between disciplines and parties whilst using the room. This room is also used for well planning and reservoir evaluation purposes. It is also used in a real-time mode particularly whilst geosteering in the reservoir. Two smaller operations rooms are shown in the upper central picture in Figure 2 together with three offices to the upper right. One of these is dedicated for Well Service operations where for example stimulation work is supported remotely. The other is used as an overflow room during high activity, or when tight hole conditions exist.

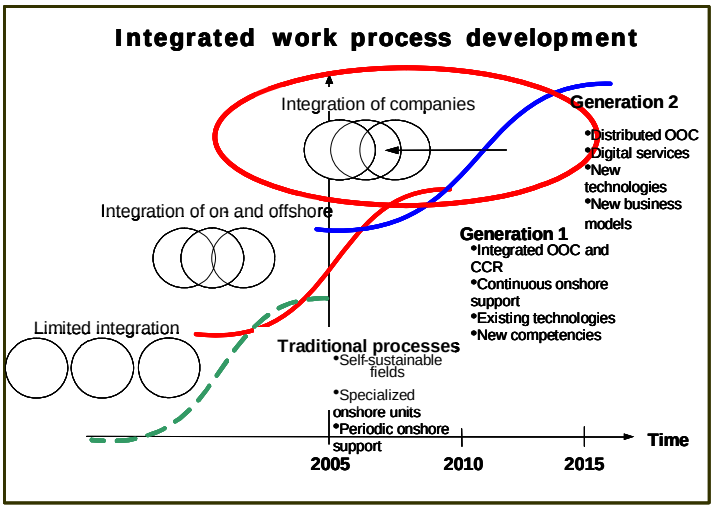

Figure 1: Evolution of integrated work processes from Traditional to Generation 2.

The ODC, and related offshore systems that serve and support our Drilling and Well operations initially cost USD 4 million to set up. This includes refurbishing of office space and improved ventilation facilities. All the equipment used in the ODC was “off the shelf” equipment, that is no prototype equipment units were required. A result of this has been that the ODC has not experienced any down time owing to faulty equipment systems.

Documented savings from using the ODC compared to conventional operating costs has shown that the ODC was initially benefiting positively by over USD 1 million per month. This sum has steadily increased to USD 1.5 million per month. These savings do not include the benefits of increased oil production volumes gained from the use of the visualization room while drilling.

Over 900 helicopter seats have been saved within the period of operation, and the number of offshore days reduced by over 9000 through the use of the remote working practices, video-conferencing, and the use of real-time data and information. There has also been a positive impact on HSE as a result of utilizing remote working practices. Interestingly HSE is seen as one of the key drivers for IO in Norway by the authorities.

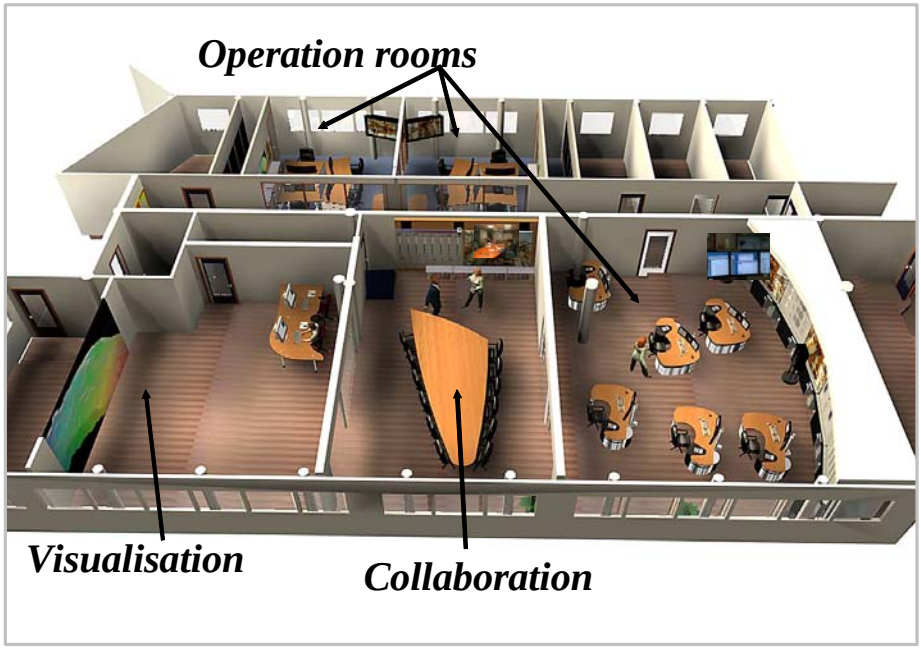

Figure 2: Inter-related operations rooms in the COPNo. Onshore Drilling Centre in Stavanger, Norway.

To further enhance the work environment that supports offshore and the ODC operated functions, COPNo. has moved two drilling teams into a semi-open plan office arrangement where operations screens and monitors have been placed in and

around the teams displaying their respective operations information, Figure 3. This change in work methodology has taken the ODC facilities to the drilling teams and engineers instead of requiring them to visit the ODC rooms. It also allows improved collaboration and knowledge sharing within the teams for each of the Operator's assets, and also cross asset collaboration. Each of the teams also has access to video conferencing, collaboration areas, and a wireless network allows flexible phone and PC setups. The wireless system also senses non ConocoPhillips computers, and then allows them access to the Internet, further improving inter-company collaboration and communication.

An R&D project is also examining how the teams work in this environment, including the decision making process, and how team members adopt and utilize the technology.

COPNo. also surveys those persons who have or are working from the ODC as to their impressions, concerns and other work environment considerations.

Offshore, each of the drilling facilities has video conferencing facilities, collaboration tools including portable and wireless Visiwear camera/sound systems. There have been installed a number of small Cisco access points with long antenna cables protruding out into areas of interest where you are only allowed to use intrinsically safe electronics (the VisiWear camera is EX certified). A wi-fi radio module inside the battery operated camera communicates wirelessly with the access point, making it possible to send live video images to and collaborate with experts onshore. COPNo. is currently working closely with the vendor to develop the next generation camera.

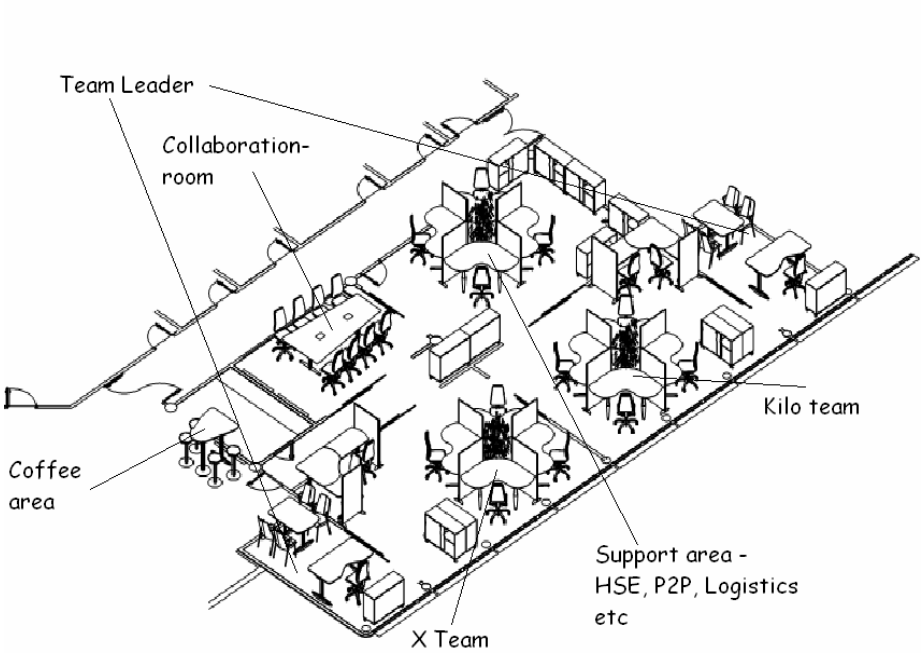

Figure 3: Semi-open plan office arrangement where operations screens and monitors placed in and around the teams display respective operations information.

Technology and Equipment Enabling Operations

In 1998/1999, a 1143 kilometer long fibre optics cable with 24 fibre strands was run from Kaarstoe on the west coast of Norway, via the North Sea oil platforms Draupner, Ula, Ekofisk, Valhall and Murdoch, to Lowestoft in the UK. COPNo. utilizes part of the capacity of one pair of strands in this cable for a 2 x 155 Mbits/sec data connection between the Ekofisk field and the offices onshore. The Ekofisk area, which consists of many platforms, is interlinked with fibre optic connections or high-speed radio links, in turn meaning that the lowest bandwidth available to shore from any COPNo. platform on the Norwegian Continental Shelf is 155 Mbits/sec.

This huge increase in available bandwidth, compared with traditional offshore installations, has revolutionized the communication between onshore and offshore.

Key types of services delivered through the cable include:

- Telephony
- Video conferencing
- Closed Circuit Television (CCTV)
- Direct communication between handheld UHF radios offshore and phones onshore
- Wireless video and audio communication between VisiWear units offshore and PCs/video conferencing equipment onshore
- Wide variety of real time data transfers
- Remote support / remote control

Video conferencing, once regarded as too unreliable or cumbersome to use - or simply not feasible in an offshore environment - is now a business critical service within ConocoPhillips in Norway. About 2,500 video conference meetings are held each month, the majority of these between onshore and offshore. Moreover, the demand for point-to-point and multi-party conferencing continues to increase.

The Learning Curve and the Future

The ODC is differentiated from other IO centres in that it combines operations rooms, collaboration rooms and the visualization room as an information unit. It also includes both Operator and Service providers in the collaborative environment, enables cross discipline and cross company integration. This ensures improved work processes and support throughout the whole process from planning to execution, and including the post well feedback. It is also intimately linked to the other IO processes of COPNo, such as Production, Logistics, and Planning and Scheduling. COPNo has an Onshore Operations Centre which covers these business processes; the centre is also linked to external centers such as the Aibel project and modification centre.

The experiences of working in this environment have shown that individuals react to the information facilities and information availability in differing ways. The change in management processes and work processes are seen as key areas needing more focus. Changes have also been realized affecting the offshore positions of COPNo. and service providers. For example, the drilling supervisors perceive that their decision making responsibilities can be taken from them. It has been made clear that this will not be the case and that the staff in the ODC is there to work remotely and support the operations only.

Onshore, in conjunction with the drilling team overviews, there have been up-grade changes for the individual COPNo. engineers. To facilitate the availability and broader use of the real time information onshore, all persons in the drilling group have been given dual PC screens improving operations monitoring opportunities. They have access to most data and information that is transferred in real time from offshore.

ODC Operations – Today and in the Future

Initially some disciplines that were referred to as data functioning positions were transferred to the ODC. They include data logging, measurement-whilst-drilling (MWD), operation geology, and various other data intensive services. Re-locating these functions was a significant step change to the conventional work processes. Directional drilling services are also performed from the ODC, notably when drilling operations are in the geo-steering phase of the reservoir sections. The operational geologists, the MWD engineer and the directional drillers collaborate very tightly throughout this operation.

COPNo. currently monitors and, to some degree advises the 4 – 6 drilling operations simultaneously from the ODC. Many drilling service companies also use the ODC as a central base for overseeing rig operations including maintenance activities. As maintenance services are primarily preventive and are generally of a scheduled nature, the procedures can just as easily be administered from the ODC as from an offshore office.

However we are seeing increasingly drilling service companies establishing their own collaboration facilities. COPNo. has established a standardized way of linking these vendor facilities to the ODC, so that the vendors can remotely support their equipment offshore, even if it is connected to the COPNo. network. They can also view CCTV screens, use UHF communications, receive real time data, have access to the video conferencing and portable Visiwear systems directly from their offices.

In many ways, COPNo.'s current operating environment can now be labeled "Generation 2" as per Figure 1, thanks to the tight integration of the involved companies.

The geologists are able to use recently introduced offshore digital microscopes to assist with critical casing picks. This function is performed by having formation samples cleaned for digital photographing and the resultant photos sent onshore for analysis and comment by a team of geologists. In fact, the microscope can be remotely controlled from onshore when required. This practice strengthens the earlier position of one geologist in the field performing the same function. The photo shown in Figure 4 indicates the quality and detail possible.

Figure 4: Photographic exmple from offshore digital microscope: Mixed claystone assemblage; Brick red, fg, claystone, mod Hd, v. slightly calcaereous, (caving?); Olive-green black, fg, claystone, soft, non-calc; Rare micas, graphite, lmst (LCM material; Rarely pyrtic.

COPNo. has a number of new projects under development for application to operations in the ODC.

The future in the area of IO in the drilling and well service environment will be one where visualization, simulation and virtual reality will be common tools to aid decision making, and integration across disciplines and companies. One of these new tools is the E-Drilling project, Figure 5, which is looking at processing the current and future dramatically increased real time data and information in a much more visual manner than today. The core application will be able to advise the user on actual and potential drilling problems by analyzing current information and performing simulations to predict future performance. The information that will be displayed uses techniques learnt from the Gaming industry to quickly update, display and share the virtual scenarios.

Data quality is a key area of focus and a Data Quality Model within the E-Drilling application uses mathematical techniques to analyze the large volume of real time data. It intelligently analyzes and filters the data to reduce uncertainties and hence improve the quality of decisions that use the data. This facility is recognized as very important for helping determine operational procedural or management practices.

Other applications where visualization of data and information play a key role is our 3-D tool for handling logistics operations. A computer generated 3-D model of our area of operations is constantly being feed with real time position data of supply and rescue boats, meteorological data and materials shipping manifested information, allowing the onshore logistics coordinators a much improved view of the field wide situation, see Figures 7 and 8. A web interface also allows the customers to have access to much of this information. For example a SMS can be sent automatically from a boat that is shortly to arriving at the location offshore or onshore. This will allow better preparations to be made prior to a boat's arrival consequently reducing turn around time.

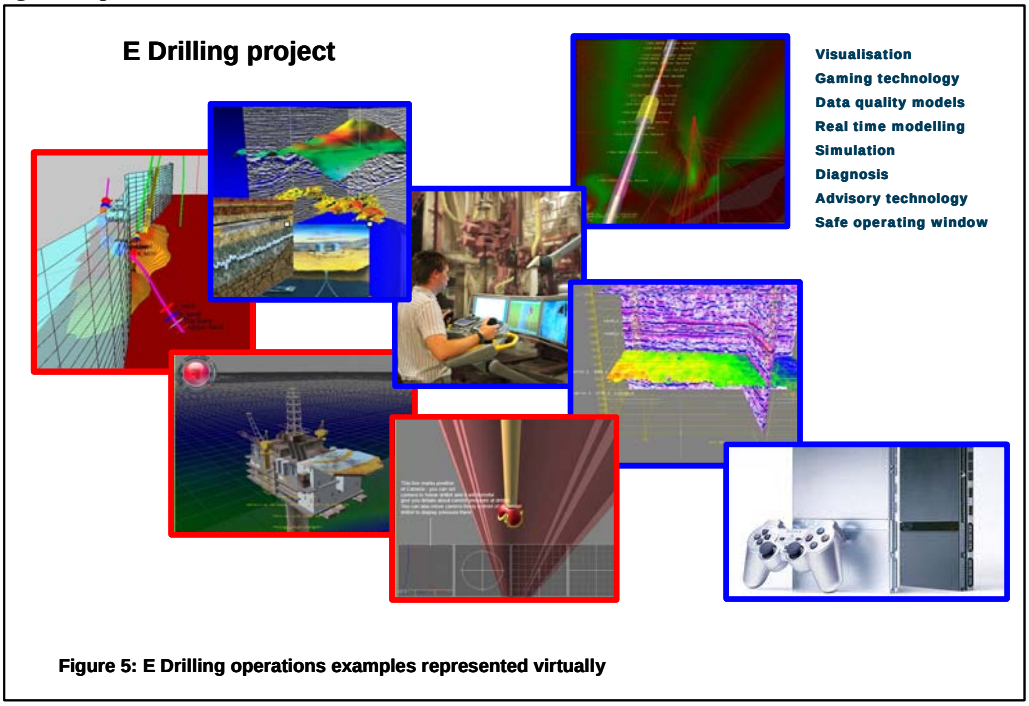

Figure 5: E Drilling operations examples represented virtually

Hydraulics services are also provided remotely and real time at request for critical wells such as exploration wells or the recent casing with drilling operation. The COPNo. drilling fluids service provider is currently attending to three fluids related projects:

1. Real-time hydraulics: The fluids service provider has implemented a real time hydraulics program that is coupled to an interactive 3-D visualization system, Figure 6. The simulated wellbore graphically shows the well, well path, virtual drill string, string contact zones and coloured displays showing wellbore fluid flow patterns during drilling, tripping, and running casing. The system is designed such that the virtual wellbore can be independently navigated on different PCs connected to the ODC network. Also, one of the navigation screens can be simultaneously displayed on any of the large screens in the ODC operations room. Drilling parameters are being coupled to this virtual well using a heads-up display.
2. The application of a device that can automatically measure and electronically report the drilling fluid density and funnel viscosity continuously. This information will then be available in the ODC and also for the drilling supervisor, driller, and other positions requiring the information.
3. The application of a variable speed viscosmeter that will provide the typical 6 shear speeds electronically, and have the ability to remotely load a control-heated chamber with a drilling fluid sample, perform the required measurements, empty the chamber and self-clean in preparation for the next sample. In addition this instrument will have the oil based mud electrical stability characteristic measured and reported as this characteristic can be related to

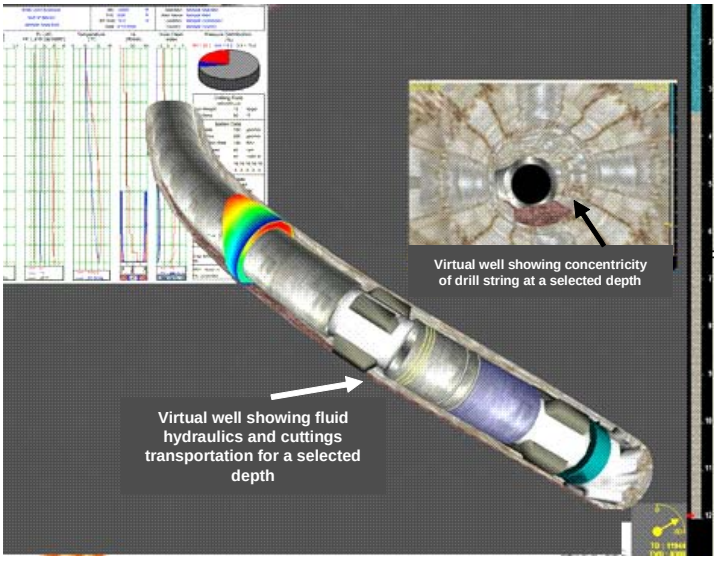

Figure 6: Visualization of a 3-D virtual well real time

the rheological profile gained form the variable speed viscometer. This electronical information will be available in the ODC and other locations as required.

4. Another future focus area will be to address decision making in the new virtual environment, as a result of IO. It will demand better collaborative and structured decision making processes which will potentially use Bayesian networks and artificial intelligence to dramatically improve team performance.

Well intervention operations conduct their acidizing well stimulation procedures from the ODC today. Prior to the availability of operating from the ODC, acid stimulation operations were conducted with a COPNo. reservoir engineer on the stimulation boat. This person was transferred to and from the boat in a personal basket. Information pertaining to the stimulation operation was processed onboard the boat.

Today the operations are overseen from the ODC with all pertinent information being communicated via a platform or satellite link as necessary. All aspects of this operation are now directed and controlled by a specialist team functioning from the ODC. These operations have been conducted without any communications incidents.

Some examples of other operations that have been or are conducted in the ODC are:

1. Several liner cement operations were monitored but not controlled from the ODC.
2. A wellbore strengthening operation of a critical well section. Operations information was displayed on the operations room and office computer screens for coordination and control. Offshore, Norwegian and Houston, USA persons were involved simultaneously.
3. A mud engineer has overseen operations on an operation from the ODC with the goal of learning what tasks or offshore responsibilities could be assumed from the ODC. This exercise included having the driller, derrickman and other offshore positions communicating with the ODC mud engineer instead of the mud engineer on the platform. The result was encouraging and particularly so with regards to changing an established work culture.
4. Remote planning and inspection work carried out ultilising the wireless camera system, even from as far a field as Houston.
5. We have performed monitoring and control whilst making up tubing from the ODC.
6. Improved training of new engineers alongside experienced operators in the ODC, including play back of events.
7. Remote Directional Drilling is currently being developed, and some operations have been run from the ODC
8. Drilling optimization and Bit optimization has all been done in the ODC, or from the service provider.

Finally in order to address demographic, and competence challenges facing the industry, several iniatives with both the University of Stavanger (UIS), and the University of Trondheim (NTNU) have been instigated, to help develop competencies in the area of IO. Several courses and visits have been performed over the years, with heavy focus, on interactive participation from the sudents. They can see how the technology is being used, in a real world situation and they also have the option to discuss this with the actual users, rather than through traditional classroom interactions.

Summary

1. The Onshore Drilling Centre (ODC) at the COPNo. offices in Stavanger, Norway consists of a group of inter-related operations rooms.
2. The ODC is differentiated from other IO centres in that it combines operations rooms, collaboration rooms and the visualization room as an information unit.
3. The ODC is realising significant economic and HSE benefits.
4. Establishing and operating the Onshore Drilling Centre has required dedicated management leadership and support.
5. Use of the ODC has improved decision making processes and results.
6. Operational Geologists, Measurement-Whilst- Drilling (MWD), Data and Logging Engineers, Directional Drillers, plus others, routinely work remotely today from the operation room.
7. Changes in the way persons integrate must generally be encouraged.
8. Automatically operating data gathering technologies are being developed specifically for the purpose.
9. Visualisation tools are becoming more widespread, to better display and use all the real time data, and allow better cross disciplinary collaboration.
10. While pre-planning for operations from the ODC is important, actual ODC operations often identify new and unrealised task challenges.
11. Moving the drilling teams into the ODC environment has removed many cultural barriers and stimulated a new operations approach.
12. Smart use of electronic collaboration tools makes it possible to improve the utilization of the existing work force by taking out non-productive time that otherwise would have been spent traveling or waiting.

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Nomenclature

CCR = Communications Collaboration Room
CCTV = Closed Circuit Television
COPNo = ConocoPhillips Norway
EX = Explosion Proof Rated
HSE = Health, Safety and Environment
IO = Integrated operations
ODC = Onshore Drilling Center
OLF = Norwegian Oil Industry Association
OOC = Onshore Operations Center
PC = Personal Computer
P2P = Purchase to Pay
R&D = Research and Development
UHF = Ultra High Frequency
USD = United States Dollars
3-D = 3 Dimensional

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[2] The Norwegian Oil Industry Association: http://www.olf.no/?32756.pdf
[3] The Norwegian Oil Industry Association: http://www.olf.no/english/news/?52210
[4] The Norwegian Oil Industry Association: http://www.olf.no/io/arbprosesser/?30333

Figure 7: Supply Boat and Proximity to Platforms

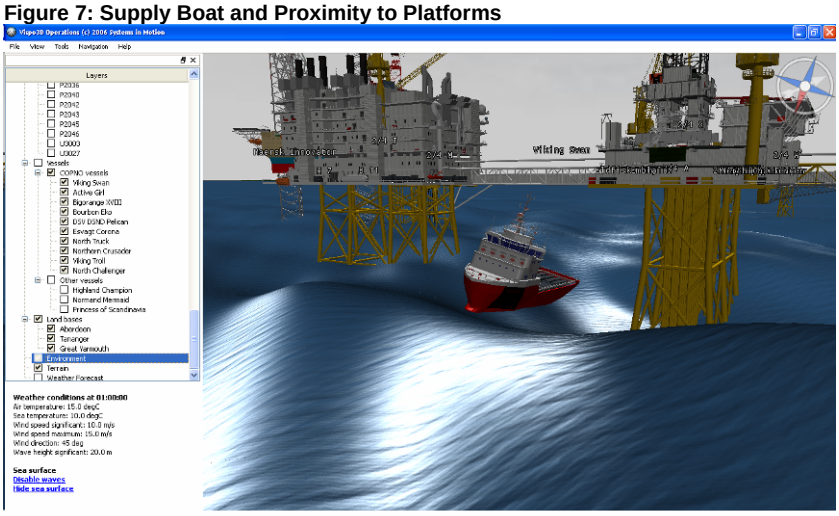

Figure 8: Supply Boat and Proximity to Platforms