University of Stavanger

**Faculty of Science and Technology**

# MASTER'S THESIS

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# *Human Factors, Technical and Organizational Issues in Onshore Operation Center: Challenges, Best practices and Recommendations*

University of Stavanger

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## Abstract

The master thesis intends to identify Human factors that include human characteristics, mistakes, working conditions, and changes in human performances, and to identify Technical challenges that include operational delays, technical limitations, standards and cost-affect, and to identify Organizational challenges that include work-flow delays, decision making errors and hierarchy levels. Discuss and define the above challenges and limitations with oil and gas operator's onshore operation center personnel. The goal is to identify factors, issues and challenges that can make onshore operations more safe and successful. Interaction and meetings are reviewed in order to better understanding the complex system operation at onshore CR. Integrated operation (IO) knowledge was introduced, which includes the onshore operations, network upgrades, and sophisticated automated system implementation and latest integrations techniques. At last some conclusions concerning the challenges involved, limitations discussed earlier, best practices and some recommendations were presented to improve the business and production performances.

## Acknowledgement

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**Mr. Antony Waly,** System designer, ABB AS, who gave me the technical system performance and its applications, which is main aspect in onshore control room. His ideas created me to research much further and make good recommendations and best practices in the common onshore operations.

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Krishna Raju Vulchi,

$14^{th}$ June 2011, Stavanger

# Table of Content

# 1. Introduction

This introduction directs to the onshore control room activities and functionalities with complex technology in complex organizations. By following detailed explanation reveals the background and significance of the onshore operations

## 1.1. Introduction to Onshore CR

Since the rise of industry era, control rooms have played significant roles in various industries as the center of human and technology interactions. The concept of control room applications in the high complex organizations is to make use of the available sophisticated technologies to control and monitor the main business operations including production, manufacturing, logistics, service providing, and etc. The implementations of control rooms have mostly claimed to increase business profit, improve operational performance, and reduce production losses.

During the last decade new technology have made it possible to increase onshore operations (with onshore CR or Onshore Operation Center (OCC)) of offshore Oil and Gas (highest complex system) installations are increasing. The motivation for onshore operation is mainly reduced hazard exposure of the employees. The thesis report is made on a survey within the Oil and Gas industry and relevant issues and best practices from ABB AS and BP. Several findings were common across the Oil & Gas industries, suggesting that it seems to be possible to learn from other industries about onshore operations. Key issues are to develop technical solutions coordinated with organizational development and training in collaboration with the operators/humans. Some recommendations are proposing to overcome the issues with co-ordination between human, technology and organization and use the thesis result in methodologies to be used by the oil and gas industries in Norway for successful operation of onshore CR. In this thesis document Onshore CR used more frequently, is same as Onshore Operation Center.

The Oil & Gas companies have a strong demand for onshore operations, primarily due to the following reasons:

- Reduced Operational Costs

Through the elimination of offshore travels, offshore double payments greatly reduce the costs associated with operation of complex system.

- Improved Flexibility

Onshore CR operation allows technical operating equipment to be positioned easily as required. No worries with space allocation in onshore

- New Applications

Due to much more flexibility in onshore there is a possibility for new applications to be implemented and tested, where else in offshore there is much risk factors will come into picture.

- Improved HSE

Onshore CR operation is much safer and environment friendly than operating offshore CR, whereas offshore CR is directly exposed to high risk environment. Onshore operation will avoid the feeling "Working under Hydrogen bomb".

One of the oil and gas producers revealed their issues and risks in quarterly magazines [ABB internal magazine, 2010] about the problem of human mistakes and organizational challenging issues with onshore operation of platform. This leads to the initiation for this master thesis study. This thesis report utilized the whole subject knowledge of Human-Technology-Organization and applying for the challenging issues in onshore operation center.

In Norway most of the Oil and Gas producing customers are thinking about remotely operating offshore from onshore operation center. ConocoPhillips started the first onshore operations in Norway. The Onshore Drilling Centre (ODC) is running and operating in Stavanger, Norway. BP has started and running onshore operation center at forus, in Stavanger for some parts of the platform. Statoil has recently started thinking and working for onshore operation center (Onshore CR)

## 1.2. Common definitions

Some of the common definitions listed below are very useful in the operation of onshore control room. [ABB internal documents, 2009]

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| Integrated Operations | Integrated operations (IO) is a collective term or concept that carries the benefits of better use of competencies – across disciplines, location and organization – in a way that makes decisions safer, faster and of better quality. The goal is to make operations and asset management more efficient through the integration of data and models, and utilizing the powers of cross-disciplinary teamwork and work processes. It is considered to affirm a new era in offshore and subsea oil and gas development and operations. |
| Human Factors / Human Factors in Onshore Operations | Human Factors are the study of human beings and their interaction with products, environments and equipment/ systems in performing manual or automatic tasks and activities. The focus in further development shall be put on application of knowledge about human capabilities, limitations, and other characteristics to the design of the Human Machine Interface in systems. Common Ground and similar face plates between Offshore and Onshore CR is mandatory and should be prioritized. |
| Multidiscipline Integration | Multidiscipline support is a horizontal seamless integration between various sub-systems to ensure multidiscipline functionality on a common work place. Furthermore ensure the beneficial of common HMI, Work-faces and to achieve soother collection and fusion of information. |
| Onshore Support | Onshore Support is when the onshore organization mainly acts as a support organization for the offshore operations; some of the routine tasks which can be conducted during normal office hours can be handled by onshore staff. More specialized support from onshore is usually initiated by requests from offshore operations to the onshore support organization. Operational liability will be allocated locally on the platform or platform group. |
| Onshore Monitoring | Onshore monitoring is a continuous process to invoke condition, status and performance of inventory and transfer data and |

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| | information to Onshore Maintenance Center (OMC). The OMC can online invoke and adjust operational parameters and schedule preventive and corrective maintenance. Operational liability will be allocated locally on the platform or platform group. |
| Onshore Control | Onshore control is defined as partly or fully remotely supported from an Onshore Operation Center (OOC) in a pre-defined pattern, where roles, tasks and responsibilities is clearly defined between the two control room facilities. The design will be prepared for a Multi-integrated and multi-disciplinary system to allow and ensure fully remote control scenario. |
| Onshore Operation | Onshore Operation is defined by that the entire platform is controlled and operated from an Onshore Control Center (OCC). The operational responsibility is entirely transferred to the OCC and is typically designed for minimum/unmanned platforms or sub-sea installations. |

## 1.3. Problem Definition

The offshore production platform is one of the toughest, critical and complex working environments. Onshore control room is the remote control possibility for the offshore operation. The complete onshore operation is not able to succeed due to the human factors includes human mistakes, personal behavior, physical challenges and such, technical issues includes technical limitations, technology ageing, network delays and such, and organization issues like organization barriers, organization hierarchies, and organization culture. Due to above issues the onshore operation center is facing serious consequences and also not able to fulfill the organization requirements and production goals about operating offshore production platform.

## 1.4. Objective and Scope

This thesis objective is derived from the above defined problem. Thesis goal is to gather experiences from offshore Oil and Gas industries to identify toughest challenges and best practices related to onshore control. Operating offshore Oil and Gas platform with onshore CR is complex environment where deviations can create serious/hazardous consequences. This thesis focused on the use of onshore control rooms and the issue of collaboration and co-operation with the central control room and between the central control room and out-side operations. In Oil and Gas industry there was extensive cooperation between offshore production process and operators in the offshore control room and onshore CR with external experts.

The following key tasks/jobs are identified to achieve above objective. This thesis study and the results are derived from so many different methods of investigations which described in further chapters.

- Identifying keen limitations and traditional boundaries in Technical and Organizational areas
- Identifying behavioral changes of Operators/humans at onshore CR
- Interviewing on working conditions, efficiency of system operation, Training etc
- Providing latest ideas/methods or best practices to overcome the challenges

## 1.5. Method of data collection

The following few methods are directing this thesis study to achieve the defined and required goal.

- **Directional Questions**

In order to achieve the purpose and scope of the thesis with the direction according to the basic questions below:

- What are the factors/criteria that affect the performance of the Onshore CR?
- How can the usability of control system in onshore CR be improved?
- How to improve the efficiency of information technology to achieve real time operations?
- How to improve business, production performance and business profits by managing human factor/mistakes, organizational issues and technical issues?
- What are the characteristics of the control system/information technology at onshore CR that affects operators and organization?
- What are the characteristics of the human, workplace that affects organization and onshore CR efficiency?
- What are the characteristics of information technologies that should be used to support control functions?
- What are the characteristics of Organization that should be to support onshore CR functions and efficiency?

The answers for the above questions lead to the experiences with problems, recommendations and best practices for the onshore operation.

- **Literature studies**

Literature studies in this thesis have been used to know existing ideas on operating onshore CR and new ideas in the technology as well as organization and ergonomics. Main literatures used for this thesis are "Design and Operation of Complex technological systems " by Jayantha P Liyange (UiS) and Jan Heimdal (IFE) and the compendium for the subject MOM 410 Human-Technology-Organization by Jayantha P Liyange (UiS) and other literature followed for more information as listed in references at the end

- **Websites**

Internet is used as supporting source of data and information collection in this thesis, Google is the major source. In finding support information, the keywords; ergonomics, control room, human-computer interaction, onshore CR, technical issues in CR, organizational challenges in onshore CR and safety environment, and Integrated operations are frequently used. Finding information from websites also takes parts in guiding the direction for this research.

- **In-Depth interview with Onshore CR operator**

The in-depth interview with few operators/humans operating control system through information technology in onshore CR, Operators gave me solid information about organizational conditions and challenges involved. Through their massive years of experience, they are able to operate complex system successfully. The interview gave me the issues and best practices from user's perspective. The interview questions can be seen in Appendix A.

- **In-Depth interview with IO engineer for Onshore Operation Center**

The in-depth interview with IO engineer and Automation engineer supporting control system through organizational conditions and ethics in onshore CR, they gave me solid information about organizational culture, boundaries and limitations involved. Through their massive years of experience in production, is able to operate complex system successfully. The interview gave me the issues and best practices from organization's perspective. The interview questions can be seen in Appendix B.

- **In-Depth interview with control system design engineer**

The in-depth interview with a control system design engineer, designer has gave me open-end information about technical solutions and challenges involved. Through his years of experiences over a decade, he has gathered and developed his knowledge in system user interface design, improvement and Integrated Operations. Moreover, he has witnessed successes and failures of control room improvements over the time. The interview gives the viewpoints from designer's perspective through controlling system usability support for operators/humans. The interview questions can be seen in Appendix C.

- **Observations of onshore control center**

Observation of onshore CR in this thesis was conducted at BP office at BP garden, forus, Stavanger. It was performed to gather the information about the control room based on ergonomics, technical and organizational perspectives. Some of the observations are

  - How are lighting, acoustics, control room layout, and furniture?
  - How are performances of the control system, speed of process updates?
  - How are organizational ethics, working procedures, barriers, and work-flow?

- **Questionnaire**

By using questionnaire the data has been collected from operators/humans, management team, technical responsible in the organization and technical system designer in Automation Company. The questionnaire result is useful to identify the challenges in the operation of onshore CR from each and every perspective.

The questionnaire is structured into 3 sections.

Section 1; general information, collects about the working performance, classify the operators, as per age, education background, characteristics of work, and etc.
Section 2; quality of work, describes/collects about the work environments. It includes Quality of working life, efficiency of current system, ergonomics, self-learning etc.

Section 3; your current working situation, collects about status before and after work, working times, redundancy in work sharing etc.

These questionnaires were handed out to staff of BP garden at forus, Stavanger and due to the limited access of the private companies for handing out. The questionnaire that is used in this research attached in Appendix D.

### 1.6. Analysis

This study report analyzes the possible implementations from the literature, websites and criticizes with the resources. In spite of focusing on only one customer and basing on one theory, the analysis part conducts to discover the overall picture of the onshore CR operation trends to discuss about the future trend for improvements based on operator's perspectives, designer's as well as organization's. Therefore, the finding result will be used as the critical resource in this research. This is to analyze the performances of the current trends, and discuss about the improvement plan for the future.

### 1.7. Limitations

Time has been a limited resource for this study. Time often influences the frame as well as the quality of the research project. In this case, a pre-defined schedule has been followed so that it had a goal and a concrete setting to use. With more time the study could have gone deeper into the material and conducted more literature search on a wider scale. This could have an impact on the total produced material in terms of findings and conclusions. One of the most time-consuming tasks on this thesis was the amount of time spent on conducting searches, decide limitations and categorize material for further investigation.

Another limitation is not having a survey to test the actual findings. The original plan was to combine the review with interviews that could inform on some of the issues identified as less studied in the literature review. Unfortunately, this was not possible. There might also be geographic differences between companies in Europe, west and the eastern part of the world, industrial countries and developing countries. Looking into these factors is out of the scope due to the time available in this thesis.

Limitation also found when reviewing the literature, unfortunately, not all articles explained well in larger and complex organizations. This applied to two articles in the literature review. Although most literature did say it was for larger alliances. Case studies can contain special activities that are only relevant to a particular organization and/or partnership. The literature reviewed is a mix of multiple partnerships surveys were used to find data that is generalizable. The data that was found belonging to one specific organization could be exclusively interesting to that business, and have no value for other organizations. The minority of the literature reviewed were case studies and conference's presentation papers.

Some articles could be classified into different groups, the focus of this review was alliance success. The field of alliances are more complex than one could expect, thus several of the identified groups during categorization could have an impact. However the time that was available did not allow 100s articles to be reviewed. The amount of articles that was found and identified to belong to Oil & Gas group was also less than one could be predicting in advance. To compensate for lack of relevant articles a few articles were found through citation of relevant literature. Some articles may represent different aspects on platform operations however still relevant to onshore operation center

## 2. Integrated operations (IO)

An integrated operation mainly refers to the new work processes and ways of doing oil and gas exploration and production, which has been facilitated by new information and communication technology. It has also taken the form of a movement for renewal of the oil and gas industry.

The most interesting part of integrated operations has been the use of always-on videoconference rooms between offshore platforms and land-based offices which includes broadband connection for sharing of data and video-surveillance of the platform. With the help of this it made possible to move some personnel onshore and use the existing human resources more efficiently. It's even possible for a team at an office in a different time zone to be consulting the night-shift of the platform.

Tools like videoconferencing and 3D-visualization also creates an opportunity for new, more cross-discipline co operations. A shared 3D-visualization may be made to fit neatly to each member of the group, so that the geologist gets a visualization of the geological structures while the drilling engineer focuses on visualizing the well. The most important thing is the real-time measurements from the well, but the down whole bandwidth has previously been very restricted. Improvements in bandwidth, better measurement devices, better aggregation and visualization of this information and improved models that simulate the rock formations and wellbore currently all feed on each other. An important task where all these improvements play together is real-time production optimization through IO.

With the deployment of integrated operations the petroleum industry draws on lessons from the process industry which can be viewed in the whole production chain and management ideas imported from the production and process industry. There are few companies which emphasize the integration and coordination of outside suppliers and collaborators in offshore operations. In terms of operational intelligence it is stated that the oil and gas industry is lagging behind other industries. In other words oil and gas industry has to focus more on IO for successful future.

Integrated operations management and work processes build on will be familiar from operations research, knowledge management and continual improvements well as information systems and business transformation.

The introduction of new technology can change the way people work. Integrated Operations (IO) and the "e-field of the future" introduce new ways of working, allowing for onshore control and virtual teams, but also raise new risk management issues. "Integrated operation means changes to organization, staffing, management systems and technology and not least to the interaction between them" (PSA, 2009). The first generation of IO is based on collaboration rooms and integration of on and offshore work processes. "Implementation of these practices will lead to relatively simple but profound changes to the traditional work processes" (OLF, 2005). The second generation of IO is based on integration not only within one organization, but between several organizations. "Implementation of these processes will lead to a closer integration of the work processes of operators and vendors and most importantly to the development of "digital services", i.e., operational concepts that are based on delivery of a large portion of the services required to operate a field "over the net" (OLF, 2005). These work processes are likely to have a significant impact on where and how people do their jobs in the future.

The tasks and functions that constitute an Integrated Operations compliant total system for the offshore platform operation:

- Collaborative production management capabilities
- Offshore system extensions for remote performance and condition monitoring
- Onshore operation center functions and IT infrastructure for onshore support
- Use of onshore expert centers, remote services and collaborative operations support
- Preparedness for remote support, monitoring and control from Onshore Operation Center

Adaptation to Operational procedures, tasks, work process descriptions and organizational charts are important activities in the design phase of IO

## 2.1 Benefits of IO

There are several reasons for introducing IO in complex organizations such as Oil and Gas industry. The economic motives include:

- Increased exploitation [Ministry of Petroleum and Energy 2007a]
- Accelerated production 5%-10% [OLF 2005]
- Reduced operating costs 20%-30% [OLF 2005]
- Higher safety levels
- Extended field life
- Enhanced oil and gas recovery (EOR) 3%-4% [OLF 2005]

## 2.2 Integrated operations and the oil& gas ontology

The Norwegian Oil Industry Association (OLF) has defined the term Integrated Operations (IO) as "real time data onshore from offshore fields and new integrated work processes". OLF has estimated the economic potential of IO to be in the magnitude of 250 billion NOK. Below Figure illustrates OLF's plan for IO adoption.

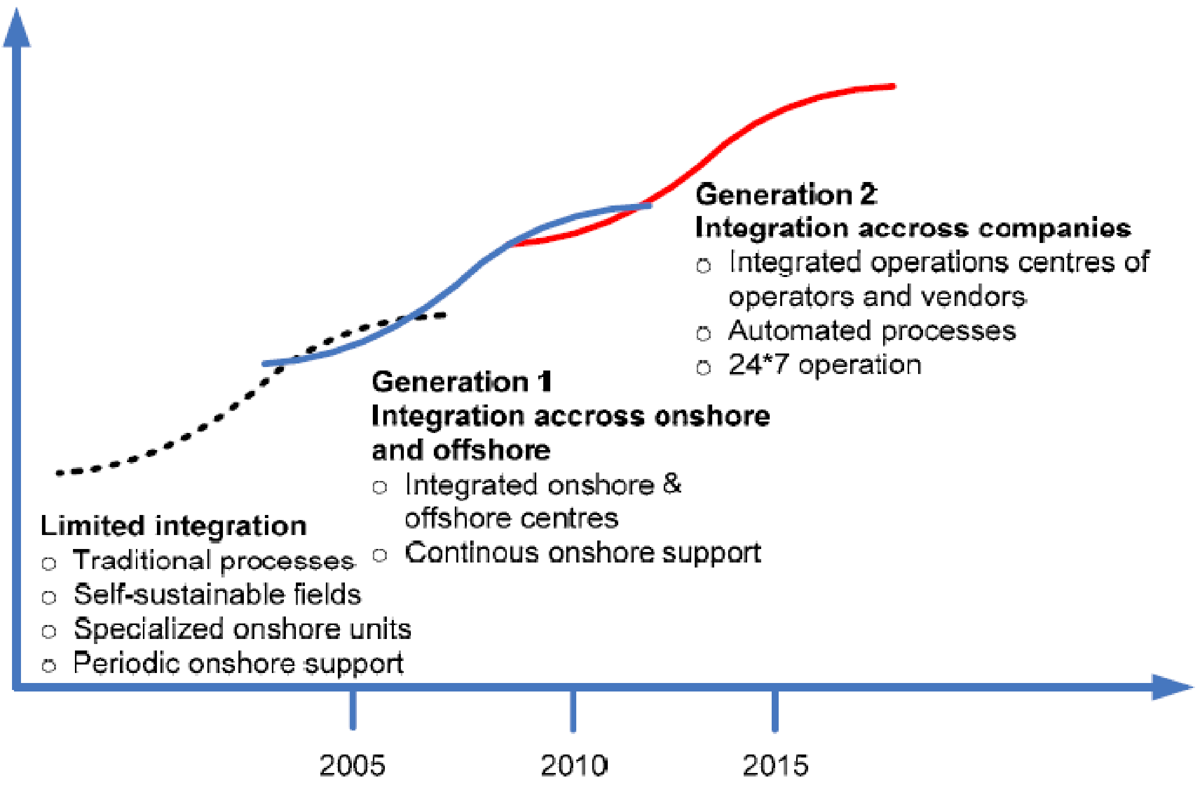



Figure -- OLF plan for IO [OLF, 2005]

Generation 1 activities include:

- Establish the required physical infrastructure such as the required computer networks and fiber optics.
- Move experts from the platforms and drilling rigs to onshore centers. I.e. for ex. enable experts on duty in Houston to assist a drilling operation in the Barents Sea, having the same situation awareness as the driller.
- Development and implementation of new business processes to take advantage of the Field technologies.

Generation 2 activities include:

- Development of the Oil & Gas Ontology based on ISO 15926.
- Development of a new generation IT systems designed to transform huge amount of data into decisions and advice.
- Tailor organizations to utilize the potential offered by fielding of new technology

For major actors at the Norwegian Continental Shelf (NCS) the focus now is implementation of generation 1 solutions. The experience so far is that this, for many reasons, is not a trivial task. One is organizational. Changing safety critical processes is a daunting task that requires a careful approach. Another is technical. The architecture found in the existing IT solutions does not support the new concepts of operation. Despite the challenges, implementation of IO has proved successful with respect to return on investment (ROI).

Historically the instrumentation and automation efforts of production assets have been rather Rudimentary, where the industry has automated when they needed to, not when they could. With the development of cheap and reliable sensor technology, the idea of increased instrumentation has emerged. The rationale is simple; with more data available, we are able to make better decisions, and thereby improve the recovery rates and reduce the operational cost. The challenge is not that humans are not able to process and use the available high volume data streams, nor are the legacy IT supporting today's manual business processes.

The practical impact of this is that OLF's vision for IO generation two requires fielding of a new generation IT systems. These systems must be architected to interoperate across assets, operations centers and corporate boundaries in a timely and secure manner. They must also compensate for the inherent weaknesses found in existing legacy systems.

## 2.3 IO Functional Requirements

Some of the functional requirements for Integrated Operations in complex working environment as described below:

### 2.3.1 Motive / Business drivers

The drivers for introducing integrated operations are:

- Reduced Operational Expenditure (OPEX)
- Reduced downtime
- Increased production
- Improved operational safety performance

This strategy outlines the equipment and systems which is required to enable these benefits. In addition, correct work process must be introduced as the benefits comes as a result of the complete chain from instrumentation, to information management systems to a decision maker which can utilize the technology by making better and faster decisions.

One key factor to be taken into account is also cross discipline issues which require supporting system design.

Decisions on organization of operation and maintenance tasks must be evaluated separately. Topics that need to be answered are whom are the users of the different applications and information gathered, where shall the user be located, shall campaign based maintenance be utilized, etc.

### 2.3.2 Systematic approach

An IO has to compose a total system-of-systems with components for SAS, IMS, AMS and Condition Monitoring Systems packages that comply, or have an acceptable deviation or workaround, to the governing industry standards, guidelines, rules and regulations within each of the IO functional aspects:

- Security
- Safety
- Availability
- Maintainability
- Usability
- Interoperability (IO Compliance)

These criteria apply and need to be evaluated across disciplines and system boundaries, amongst these are Automation, Information Communication Technology, Electrical, Information Management and Software, Telecom, Asset Management and Human Factors.

### 2.3.3 Open standards and integrated systems

The IO topology and systems architecture with proposed SAS components are based on open standards such as OPC, Hart, XML, API. For associated SAS components such as smart instrument devices (e.g. process control valve positioner) and electrical interfaces, open interface standards should be selected.

### 2.3.4 Collaborative information management

To support cross discipline operational support, the information management systems must be open and support both production and maintenance issues. This imposes information system requirements which traditionally not have been included in the given design specifications. Key factors are: easy access for several user groups, with consolidated data from several sources.

Requirements are:

- Time tagging at source with high accuracy
- Sampling interval must be set so that the process is observable
- Consolidating architecture where several systems is interfaced to the same system
- Include alarm and events
- Include maintenance alerts and maintenance related information
- Easy access for the users
- Open to integrate with applications
- Open standards for easy software applications interfacing

### 2.3.5 Operations Information Management and Visualization

In an environment for Integrated Operation, data presentation to users and the transformation of 'data to information' is highly important. Valuable information must be identified and presented to the user in a manner that is adapted to the work processes. In this way, the data presentation layer, serve as the link between the information systems and people.

Modern collaboration solutions are essential in realizing integrated operations initiatives:

- Software and algorithms for data presentation,
- Visualization techniques and human factors engineering for control rooms,
- Operation centers large-screen displays,
- Collaborative environments and information portals,
- Intelligent information workspaces

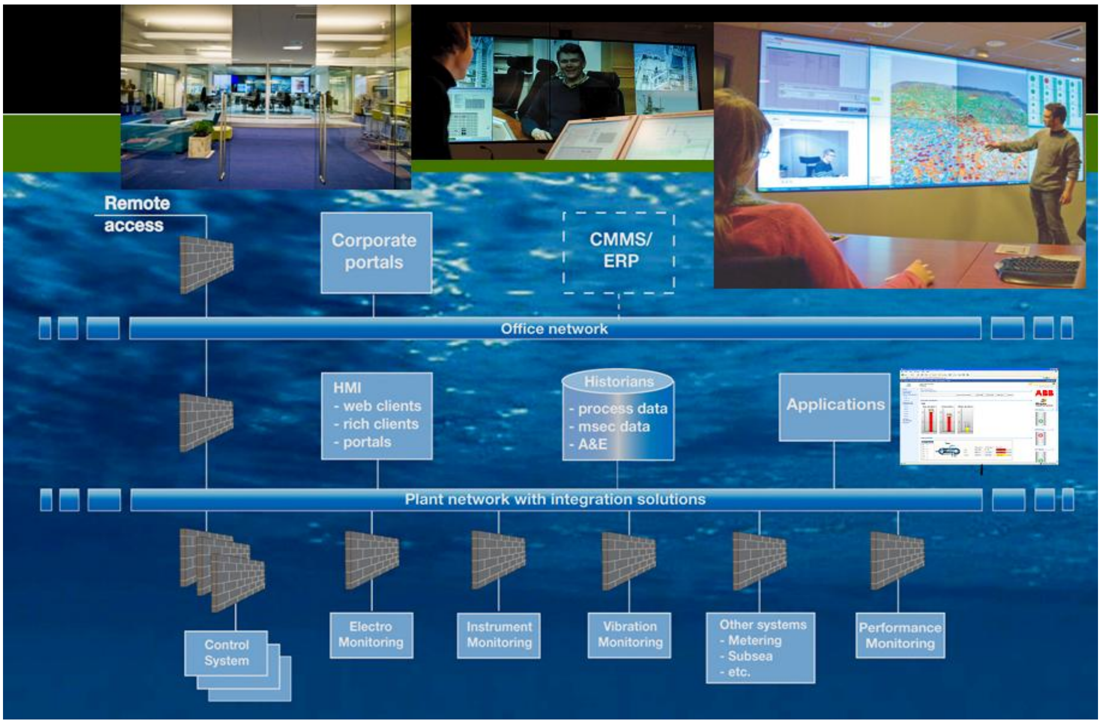



Figure general architecture for Integrated Operations. [ABB intranet, 2010]

### 2.3.6 Remote performance and condition monitoring

The main benefits of performance and condition monitoring is

- Increased HSE
- Decreased downtime, improved availability
- More efficient maintenance through predictive and condition based maintenance

In order to enable remote performance and condition monitoring it is important with both remote access to systems with regards to IT and networks infrastructure for remote analysis, data access (real-time and history data, process and equipment diagnostic data, alarm and events, maintenance data, etc.), and user displays/ graphical user interfaces.

Typically, integrated planning and daily operations support users are located onshore at the Operator company locations, at onshore operation center or Expert centers and/or with 3rd party Service suppliers. The systems topology and information management architecture must facilitate such a composite user organization.

With regards to downtime it is critical to identify the safety and production critical equipment and systems components. The SAS is such an entity (critical package) and therefore Automation Company has to propose SAS and IT monitoring including IMS Applications systems monitoring. With regard to more efficient maintenance management, it is of interest to improve the maintenance strategy and work processes as the more traditional (periodically) maintenance is labor intensive, often requires equipment downtime and includes maintenance of equipment which is not required.

The technical offshore packaged systems should provide self-diagnostics and monitoring functionality, either as an embedded condition monitoring part of the subsystem, or by allowing for an interfacing to transfer values to the above mentioned data collection and condition and performance monitoring systems. There is an opportunity to install wireless sensors for having an online, continuous measure of for example temperature and/or vibration data that are offline today. The use of this as a supplement for non-safety critical instrumentation should be investigated.

### 2.3.7 Integrity and safety overview

There are opportunities to make the offshore safety integrity visual to onshore Operations center, and also add functionality which automatically can document and check the integrity level. Subsets of this information are given by, for example, IMS applications, smart instrumentation diagnostics information such as Partial stroke for safety valves. Safety critical equipment can be monitored and integrity information made available. Personnel tracking, Meteorological data (wind, temperature), active work orders and especially hot work permits can be visualized in large screen displays and/or interactive information displays / surfaces.

### 2.3.8 Enterprise connectivity and business process management

To optimize the business operation and maintenance, it is important to interface to the maintenance management system (e.g. SAP) as this is the tool where administration and planning is carried out.

### 2.3.9 Portable and wireless systems in field

In order to improve the overall safety and let the worker in the field get access to required systems for maintenance purposes, RFID identification, PDAs (personal digital assistant) and mobile field worker equipment should be evaluated.

### 2.3.10 IT Security and Integration Interfaces

In the SAS technical, the IT security and integration interfaces are set up to allow remote access and data exchange. This is done according to OLF guidelines and what has been implemented on similar deliveries in operation in Norway.

## 2.4 Slow adopters

Unfortunately, the oil industry is a conservative business. Although there are strong forces working for modernizing the business (such as OLF), there are also people who are more satisfied with the ways things currently work. It has been said that many of the changes with IO we are seeing happening now, happened more than a decade ago in the automotive industry [Øystein Fossen 2007]. There may be several reasons for the somewhat slow transition to IO. One is that offshore oil production companies earn a lot of money, even though they are lagging in their use of technology. Another problem with introducing new technology in an oil company is that they are rather short-handed on human resources. Every work-hour spent on testing and evaluating new technology is an hour lost spending on short-term production optimization.

David Ottesen, CEO in Ziebel (a multinational company working with smart wells), said this about the situation: "The technology is here, yes. It's the determination we are lacking. The contracts are designed such that suppliers earn more when things take more time and more people are used. That is the exact opposite of what we should be striving towards" [Rasen 2008]

## 2.5 The future of integrated operations

No longer it is a matter of cost whether to include integrated operations as part of the overall long term automation strategy, it's becoming a matter of necessity. Most of the automation companies are seeing a drive towards integrated operations from the initial outset of conceptual project thinking all the way through to operational excellence as the basis of long term operations.

Several factors are driving this rather refreshing new way of thinking:

- The reducing engineering pool, and, as a consequence, the difficulty of getting the right people in front of the systems to ensure that all important production uptime.
- Providing onshore operation and technical support to remote plants. Where it is undesirable or impractical to have permanent manning with significant technical resources for the different disciplines involved.
- The locations of these facilities, which is becoming more important as some plants/ offshore platforms are becoming more remote or in environmentally unfriendly locations for permanent manning.
- Ever present demand to drive down capital expenditure (CapEx) and operation expenditure (OpEx).
- EPCs and end-users having to integrate their engineering resource, due to cost/ manning issues, which is being made easier due to integrated nature of the electronic engineering database tools.
- Ever tighter project execution schedules.

- Environmental issues such as the volatility of the oil price as well as the ever increasing demand for energy and energy efficiency (the demand in China and India is expected to increase from 105% to 195% - source IEA forecast 2006-2030)
- Operational excellence as a main project driver as operations are now being seen to be the key to successful long term profitability.
- Business decisions need to be made with real-time information and in a timely fashion to take full advantage of process variants and market conditions.
- Requirements for central production operational staff to have visibility of multiple process plant assets.

These issues are real and are here today and are facing almost every automation project. This means the future needs to be addressed now. As almost every project today is looking for operational periods of between 20 – 30 years, this traditionally conservative industry needs to make some rapid changes to ensure systems can be engineered, manned and operated during the required periods, whilst keeping pace with technology and market demands.

# 3. Human Factors

This chapter introduces and reveals about the importance of human factors in oil and gas operations. The whole chapter explains about the ergonomics, human behavior, mistakes and limitations.

## 3.1 Introduction

Human Factors Engineering is the discipline dedicated to study of human behavior in Onshore CR operation. It then applies this knowledge with the objective of minimizing human errors, minimizing the effects of any human errors that occur and maximizing the effectiveness of human performance. Human Factors has also been summarized as "making it easy for people to do things right and hard for them to do things wrong".

The principal purposes of this discipline are to ensure a safe working environment for personnel and to enhance the operability and maintainability of plant and equipment from onshore CR.

## 3.2 Concept of Ergonomics

*"Ergonomics has been defined as the scientific study of the relationship between human and his working environment." By (Murrell, 1965)*

The sentence above is one of the very first definitions of ergonomics which was raised from the sixty's. Murrell, K. F. H. was a marine psychologist who devoted his interests in the research area of psychology and physiology for human work. He became one of the very first scientists who define the word "ergonomics". According to his definition, the "working environment" covers everything that relates to the certain work of human, including the surrounding environments, tools and devices, the utilized materials, the methods of work, or even the organization of work. These factors are claimed to be related to the abilities, capabilities, and limitations of an individual's work.

Murrell's ergonomics study made use of variety fields of scientific knowledge to study on the regarded "relationship", which those fields of knowledge are originated from two main fields of his interest, human psychology and physiology. To be more clearly, psychology involves with mental function and social behavior of human while physiology relates to human body and their anatomical movements. (Murrell, 1965)

The field of psychology involves with "perception, cognition, attention, emotion, motivation, brain functioning, personality, behavior, and interpersonal relationships". These connections have become one of the most popular quotations for various sources of psychological definitions and articles over the Internet. They present excellent reference for basic mental and behavioral demand of human in their lives including the related activities in their work. Mostly, psychological knowledge is used clinically to evaluate and treat human's mental health problems. Somehow, there are many applications of its studies into various fields of human activities especially in Oil & Gas business.

Although the definitions of ergonomics have just been defined and concentrated within these five decades, the studies and developments have been performed longer than that. It is not just the integration that should be added into human's operation, but it cannot be separated. Ergonomics has been involved in parallel to the improvement of mankind's quality of life since the beginning of human era. Murrell's ergonomic studies were one of the most significant inspirations for modern ergonomics studies nowadays. Since the World War 2, ergonomics studies have become more academic, popular and more concrete. For the more recent definition, International Ergonomics Association, 2000, has raised the description of ergonomics as below.

*"Ergonomics (or human factors) is the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theoretical principles, data and methods to design in order to optimize human well being and overall system performance."*
*"Practitioners of ergonomics, ergonomists, contribute to the planning, design and evaluation of tasks, jobs, products, organizations, environments and systems in order to make them compatible with the needs, abilities and limitations of people." (International Ergonomics Association, 2000)*

As we can see that even more than 45 years, the definition of ergonomics has not been changed a bit. Although there is some difference between the current day and the olden days, they might be due to the variety in fields of application, advancement of technology, addition knowledge in physiology and psychology and some detailed factors. Nowadays, computers tend to become a part of many people's life. Numerous numbers of these technological devices are designed without ergonomic concern, and many people do not know how to use them in ergonomically. This has led the problems from computer usage to become more serious both in physiological and psychological aspects.

The concept of ergonomics applied into the onshore control room operation in order to support the operator's ease of use and usability, as well as reduce the loads in physical, psychological, and sociological problems for the operators, ergonomics is a necessary discipline to focus in the design and improvement processes. The human uses sight and sound senses mainly in control room. These physiology signals have to be processed by the brain, which determines a course of action. And other important ergonomic concept is mental state of humans to operate control room, this psychology state plays important role in onshore CR operation to cause human errors, human behavioral changes.

## 3.3 Ergonomics in the workplace

Outside of the discipline itself, the term 'ergonomics' is generally used to refer to physical ergonomics as it relates to the workplace. Ergonomics in the workplace has to do largely with the safety of employees, both long and short-term. Ergonomics can help reduce costs by improving safety. This would decrease the money paid out in worker's compensation. For example, over five million workers sustain overextension injuries per year. Through ergonomics, workplaces can be designed so that workers do not have to overextend themselves and the manufacturing industry could save billions in worker's compensation. (Rooney et al, 2008)

Workplaces may either take the reactive or proactive approach when applying ergonomics practices. Reactive ergonomics is when something needs to be fixed, and corrective action is taken. Proactive ergonomics is the process of seeking areas that could be improved and fixing the issues before they become a large problem. Problems may be fixed through equipment design, task design, or environmental design. Equipment design changes the actual, physical devices used by people. Task design changes what people do with the equipment. Environmental design changes the environment in which people work, but not the physical equipment they use (Wickens and Hollands, 2000)

## 3.4 Design of Working Environment

A part of ergonomics integration in onshore control centers relates to work environment design. The operator's performances can be increased when they have willingness to work. The increment of performances is most likely to be resulted from providing safety and security for them. Therefore, good working environment in control center has tendencies to support operator's physiological and psychological capabilities, which can also results in creating greater business and industrial operation's efficiency and productivity. [IEA, September 2008]

### 3.4.1 Physical Environment design

**Construction and interior design**: Windows, doors, furniture, and control devices should be positioned to support the operator's physical logistics especially major activities in the control center and makes the control operation flow systematically. These activities include decision making, controlling actions and information observing. In addition to the positioning, the design of the construction including the ceiling height, room size and coloring also take parts in supporting the operators in psychological aspects. When they have pleasure to work, their working performances, as well as their creativity level will be increased. Moreover, construction method and material usage have significant roles in reducing obstacles in control center, for example increasing sound absorption ability, heat protection and vibration prevention.

**Furniture facility**: In onshore control centers including operator desk, chair, bookshelf, etc. is normally designed based on ergonomics knowledge in order to support human's anatomical and behavioral properties. At the same time, because different people have different body size, (height, weight, length of organs, etc.) much furniture is designed to be adjustable. The purpose is to offer conveniences for the operator's movements including working angle, movement speed, and reach ability in performing work. In addition, they should support the positioning of related technologies to support the operator's works.

**Lighting and coloring systems**: Because the operator's eye vision is the significant capability in monitoring, lighting and coloring in control centers should be set and designed to support the control operation suitably. Significant factors that relate to the lighting system design in workplaces cover glare, reflection, shadow, brightness and illumination. The ranges of these parameters will be under operation range for better visibility and conformability.

**Ventilation and thermal system design**: Humidity and temperature are considerable factors in improving working satisfaction for operators. According to an online source of explanation, states that human skin gets rid of internal humidity by passing into air to maintain its current temperature. So, it can be verified that humidity has a tremendous impact on human body's temperature. As the relation to the operator's working condition, too high temperature in the work environment tends to reduce their stress and tension limitations. On the other hand, too low temperature is likely to reduce their concentration level in work. [Human Factors and Ergonomics Society, website]

### 3.4.2 Visual Display Unit design

Visual display system; the important asset of onshore control center is display system which is mostly separated into two parts in the design of control centers. A large screen system or wall-front display is typically seen in control centers to display the overall status of the controlled system and some of its momentous processes. Most of operators are using large screen system. The objective of using big screen system is to centralize the information which is needed to be presented and shared to all operators for discussions and decision makings. Besides, it also reduces the resource usage since there is no need to have the display system separately for each operator. [Integrated safety management ergonomics, July 2008]

Another part is the multiple displays system for specific purposes and responsibilities of each operator. This part mostly makes use of computer screen for computer systems to display the information and status of some specific functions that are not needed to be shared with the other operators. From ergonomics point of view, its main advantage is to reduce confusion in information recognition for individuals. With adaptation into control centers, visual display may be used to display the motion pictures from video recorder, or display the programmed software for specific purposes either way.
Visual display technologies should be chosen properly to support the operator's working capabilities as well as reduce obstacles in monitoring especially to their visual perception and eye movements. The related factors in designing display system are resolution, reflection, colors, viewing angles, brightness, distances, image quality, and etc.

**Cathode ray tube display** (CRT) is the first and old technology that could display pictures from the transmitted signal. The first drawback of CRT system is its size, which is large, deep and heavy. The second drawback is its technical properties, which make the quality of the displayed picture reduced along its lifetime.

**Liquid crystal display** (LCD) presented tremendous improvement result from the previous technologies at the time that it was announced. The advantage of this type of display is obviously seen from its size, which is much smaller, thinner and lighter than the CRTs. Moreover, it contains higher resolution, contrast, and better image quality than its ancestors. However, its drawback is the viewing angel, which the brightness and image quality will be lower when viewing from more and different angles.

**Plasma display panel** (PDP) is the system that was announced in almost the same period of time with LCD display system. It offers more reliable color, higher contrast, and better viewing angel than the LCDs. Nevertheless, one of its disadvantages is a significant issue, which is, its screen burns along with its usage, which also makes brightness decrease over time.

**Light-emitting diodes backlit liquid crystal display** (LED backlit LCD display) is a step of improvement from normal LCD. It is focused to be the replacement of LCDs. It has advantages over LCDs in terms of grater dynamic contrast, brighter output, higher contrast ratio, and more accurate power. Moreover, the production can offer a thinner screen and produce less environmental pollution.

**Projectors** display large size of screen on the smooth surface, flexible, easy to be moved, but needed to be used in low light environment. Using of projectors mostly be in conferences and presentations where the projector can be moved and change the source of signal easily.

Another function of information display system relates to the false and error detection and alarm systems. This type of system is used to notify the operators when the unplanned or abnormal situation occurs in the operation. It is also a substantial system that allows the operators to take action to those situations urgently to reduce losses and errors to the work. For false and error detection, sensors, radars, meters, and cameras are some examples for information display technologies that are mostly used in Oil & Gas business sectors. After the false and errors are detected, the control system will notify the operators through alarm system, which can be informed in terms of light, text, picture, sound, voice, or vibration depending on the suitability to the operation characteristics. Good alarm systems should define difference in each situation clearly and are not supposed to disturb the operators from their current works.

## 3.5 HF Objectives

The following objectives can introduce to meet Human Factors design goals and need to be accounted for during the design process: [ABB internal study document, 2009]

- Meet requirements for profitability in design and operation
- Reduce manning / Integrated Operations
- Develop multi-skilled workers/teams
- Increase automation and introduction of new technology
- Regularity – continual improvement of HSE
- Consistent HMI and user interface
- Reduce risk, implement barriers and human error focus
- Improve HSE level
- Reduce possible human errors
- Optimize operator efficiency
- Increase situation awareness and up-keep safety in all situations

To cope with the objectives the designers should ensure systematic and effective end-user and supplier's involvement and develop verification check lists to validate that the design goals are met.

This will again increase business performance and regularity in production, optimize production rates and lower training cost.

## 3.6 Limitations

1. Physical limitations: The examples of human physical limitations are body size, sight and vision, muscle and movement, hearing and metabolism rate. Noise level, air flow, temperature, air pressure, color, humidity are the related factors that restrict to those limitations. The major limitations for human that relate to onshore operation center activity are sight and vision, muscle and movement which are the criteria for using control system in monitoring and controlling. Therefore, the concerns of these limitations are critiques for redesign criteria.

2. Psychological limitations: In the human sense, they have perceptions in all kind of activities in their lives. Those perceptions have influential effects to human's attitude, which directly have effects on their working conditions and performance. Human's mental and mind limitation is dissimilar in different time depending on their perceptual condition in the surrounding environment. Stress, sense of organs psychological perception, social interaction, and pressure are some examples of the mental and mind limitations.

3. Knowledge and education limitations: This constraint limits the human capabilities with the question, “how to response with the situation?” Without certain knowledge, they work directionless, which might not lead them to achieve the main purpose of the task. This constraint is the most flexible limitation of human, since knowledge can be expanded, transformed, and transferred. However, knowledge limitation can be broken through by learning. Because human learns all the time in parallel to all activities they do in their daily lives, knowledge limitation can be changed all the time. However, for individual, this restriction is the obstacle for working efficiency, which influences the time usage in achieving tasks, quality of the finished work, and etc.

These limitations are individual restrictions of each person. However, many people share some common restrictions or there are minor differences among them, for example, movement of muscular system limitations, stress/pressure at work, and temperature/humidity in the work environment. When human has the least effect from their limitations, they are able to perform the best working performances.

# 4. Organization

What are complex organizations? They are enduring formal structures that direct human action, shape decision-making, channel wealth, concentrate power and institutionalize the ways in which people act in all spheres of society. Complex organizations are ubiquitous parts of contemporary life in economics and business, politics, the law, science, education, entertainment, the media, and leisure. People live most of their lives in various complex organizations. But beyond being "formal structures", what are complex organizations? Where do they come from? How do they work? Why are they so important in contemporary life? [Becky Richards, UMT, 2007]

## 4.1 Organizational culture

An Organization Culture with following attributes.

### 4.1.1 Definition

"The specific collection of values and norms that are shared by people and groups in an organization and that control the way they interact with each other and with stakeholders outside the organization."

It is an idea in the field of organizational studies and management describes below personal and cultural values of an organization.

- Psychology
- Attitudes
- Experiences
- beliefs and
- values

As per Ravasi and Schultz (2006), the organizational culture is a set of shared mental assumptions that guide interpretation and action in organizations by defining appropriate behavior for various situations.

Although it's difficult to get consensus about the definition of organizational culture, several constructs are commonly agreed upon – that organizational culture is holistic, historically determined, related to anthropological concepts, socially constructed, soft, and difficult to change.

### 4.1.2 Strong/weak cultures

Strong culture is said to exist where employees respond to stimulus because of their alignment to organizational values. In such environments, strong cultures help onshore operations well.

Conversely, there is weak culture where there is little alignment with organizational values and control must be exercised through extensive procedures and bureaucracy.

The organizations that foster strong cultures have clear values that give employees a reason to embrace the culture. A "strong" culture may be especially beneficial to customers operating in the production sector since members of these organizations are responsible for delivering the higher production rates and higher share value for the organization. The organizations may derive the following benefits from developing strong and productive cultures:

- Better aligning the company towards achieving its vision, mission, and goals
- High employee motivation and loyalty
- Increased team cohesiveness among the company's various departments and divisions
- Promoting consistency and encouraging coordination and control within the company
- Shaping employee behavior at work, enabling the organization to be more efficient

### 4.1.3 Characteristics of Healthy Organizational Cultures

Organizations should strive for what is considered a "healthy" organizational culture in order to increase productivity, growth, efficiency and reduce employee turnover and other counterproductive behavior. A variety of characteristics describe a healthy culture, including:

- Acceptance and appreciation for diversity
- Regard for and fair treatment of each employee as well as respect for each employee's contribution to the company
- Employee pride and enthusiasm for the organization and the work performed
- Equal opportunity for each employee to realize their full potential within the company
- Strong communication with all employees regarding policies and company issues
- Strong company leaders with a strong sense of direction and purpose
- Ability to compete in industry innovation and customer service, as well as price
- Lower than average turnover rates (perpetuated by a healthy culture)
- Investment in learning, training, and employee knowledge

Additionally, performance oriented cultures have been shown to possess statistically better financial growth especially in production of Oil & Gas businesses. Such cultures possess high employee involvement, strong internal communications and an acceptance and encouragement of a healthy level of risk-taking in order to achieve innovation. Additionally, organizational cultures that explicitly emphasize factors related to the demands placed on them by industry technology and growth will be better performers in the organization.

According to Kotter and Heskett (1992), organizations with adaptive cultures perform much better than organizations with unadaptive cultures. An adaptive culture translates into organizational success, it is characterized by managers paying close attention to all of their employees and customers, initiating change when needed, and taking risks. An unadaptive culture can significantly reduce a firm's effectiveness, disabling the firm from pursuing all its competitive/operational options.

### 4.1.4 Requirements of Healthy Organizational Cultures

**Leadership:** Organization culture is defined by the leadership of the organization. The CEO is the torch-bearer of organization culture. The mission, vision and strategy communicated by the senior management is the glue which holds the organization together and moves everybody in the same direction. Lack of clear direction, frequent and abrupt changes and arbitrary decisions in mission, vision and strategy contribute to the negativity in the organization culture. This also results in various departments having different work cultures and working in a counter-productive manner. This directly impacts the efficiency and effectiveness of business operations. Depending on the level and clarity of leadership communication, the organization at a macro level may be in high, medium or low risk as depicted in the adjoining chart.

**Ethics**: Business ethics show in all aspects of business conduct, from the board room strategies to the front desk personnel. It goes beyond legal requirements, and shows whether business is conducted on values of integrity, honesty and fairness. It shows whether employees at all levels are able to walk the talk. A clearly defined and implemented code of conduct improves the organization culture. However, an organization which has not implemented a code of conduct may have a negative organization culture. In such a case, decisions are taken arbitrarily, organization lacks transparency and may disregard laws and regulations to achieve profitability. Commitment to follow the business ethics, reflect whether organization has high, medium or low compliance risk. High compliance risk raises questions on reliability and authenticity of financial statements

**Attitudes & Beliefs**: The psychology and behavior shown throughout the organization by the employees for doing day-to-day operations reflect the organization culture. Organizations show healthy attitudes where employees are rewarded on performance, there is lack of discrimination due to age, race, color and gender and there is minimal harassment and workplace aggression. Organizations having aggressive work cultures, which are number driven and lack humanity, impact the control environment negatively. In such cases, for the sake of efficiency, legal requirements are compromised. Carried to an excessive stage, the organization may become unsafe for work and/or shareholder investments. The control environment is such cases maybe seriously impacted, as there is strong alignment towards unhealthy and corrupt business practices

The above mentioned three aspects clearly indicate that organization culture has a significant impact on control environment of the organization. An internal control auditor would benefit from understanding and assessing the organization culture. An organization risk appetite, philosophy, and exposures can be determined while analyzing the organization culture. A risk dashboard and/ or internal audit program should be developed keeping the organization culture in mind. An internal audit report must mention the impact of organization culture on internal control environment and the risks the organization is exposed to, due to negative or unhealthy organization culture. Recommendations should be given to improve and build a healthy organization culture.

### 4.1.5 Impacts of Organizational Culture

A healthy and robust organizational culture may provide various benefits, including the following:

- Competitive edge derived from innovation and customer service
- Consistent, efficient employee performance
- Team cohesiveness
- High employee morale
- Strong company alignment towards goal achievement

Although little empirical research exists to support the link between organizational culture and organizational performance, there is little doubt among experts that this relationship exists. Organizational culture can be a factor in the survival or failure of an organization - although this is difficult to prove considering the necessary longitudinal analyses are hardly feasible. The sustained superior performance of firms like IBM, Hewlett-Packard, Proctor and Gamble, and McDonald's may be, at least partly, a reflection of their organizational cultures.

A 2003 Harvard Business School study reported that culture has a significant impact on an organization's long-term economic performance. The study examined the management practices at 160 organizations over ten years and found that culture can enhance performance or prove detrimental to performance. Organizations with strong performance-oriented cultures witnessed far better financial growth. Additionally, a 2002 Corporate Leadership Council study found that cultural traits such as risk taking, internal communications, and flexibility are some of the most important drivers of performance, and may impact individual performance. Furthermore, innovativeness, productivity through people, and the other cultural factors cited by Peters and Waterman (1982) also have positive economic consequences.

Denison, Haaland, and Goelzer (2004) found that culture contributes to the success of the organization, but not all dimensions contribute the same. It was found that the impacts of these dimensions differ by global regions, which suggests that organizational culture is impacted by national culture. Additionally, Clarke (2006) found that a safety climate is related to an organization's safety record.

## 4.2 Organizational Barriers

The important aspect of the organization is organization barriers. Every organization has their own barriers which controls the execution and operation of business in a pre/defined and required manner. In complex organizations the barriers are more predominantly sensitive and important.

### 4.2.1 Basic Concept and Definition

Many organizations in Oil & Gas business have responded to the changing location of operations (from Offshore to onshore) and demographics of the workplace by implementing a variety of benefits and policies designed to help employees balance their work and non work lives. These benefits and policies are instituted with the desire to create what has been termed as the "family-friendly" workplace. Despite these efforts, there are a number of organizational barriers that can inhibit employers from developing and maintaining a family-supportive work environment.

For the purposes of this entry, organizational barriers are defined as factors that prevent organizations from implementing, and/or factors that reduce the effectiveness of family-supportive benefits and policies after they are in place.

### 4.2.2 Importance of Topic to Work-Family Studies

Because a family-friendly workplace has been shown to relate to employee quality of work life and well-being, as well as to organizational productivity (Lobel, 1999), it is important to recognize the factors that may inhibit the successful implementation and facilitation of family-supportive policies. For example, organizational work and family initiatives do not always help employees experience a better balance between work and family because many initiatives do not facilitate a better distribution of personal resources across life domains (Kirchmeyer, 2000). Knowledge of the obstacles that stand in the way of creating a family-friendly workplace can be used by organizations to develop training programs for managers and workshops for employees that better link worker needs with business goals.

### 4.2.3 State of the Body of Knowledge

Researchers and Authors have identified a number of specific organizational barriers. The barriers included in this entry are gender role assumptions, lack of national policy, rigid schedules, lack of management support, and corporate culture. These barriers do not operate independently, but rather work hand-in-hand in preventing organizations from achieving a family-supportive environment.

One barrier that prevents organizations from implementing family-supportive policies concerns prevailing assumptions regarding gender roles and their relation to work and to family (Thompson, Thomas, & Maier, 1992). Thompson et al. refer to this as the "masculine ethic" in organizations. Workplaces and their reward systems are still generally built around the male model of work. Guidelines for achieving success in organizations (e.g., assertiveness, competition, heroic action) are closely associated with conventional images of masculinity (Rapoport, Bailyn, Fletcher, & Pruitt 2002). The "ideal worker" is one who works full time and overtime and takes little or no time off from work for childbearing or child rearing (Williams, 2000). The persistent view regarding the career patterns of men and women is that women are more committed to family than to work, and that men are more committed to work than to family (Cook, 1994). Consequently, family supportive policies continue to be seen as policies primarily designed to "help" women (Lewis, 2001).

Another barrier mentioned by Thompson et al. (1992) is the lack of leadership on national policy regarding work and family issues. Although the lack of national policy might more accurately be considered a societal barrier rather than an organizational barrier, the lack of national policy provides little motivation for organizations to initiate change. As reported by Waldfogel (2001), the family leave policy of the country differs dramatically from that of other highly industrialized countries. The Family and Medical Leave Act (FMLA) of the country offers employees the right to a 12-week, unpaid job protected leave to care for a newborn or a sick family member. In contrast, the policies of other countries typically offer a longer period of leave, normally provide some form of wage replacement, and are more likely to be universal (e.g., available to all new parents). National policy helps heighten awareness of work-family issues among employers.

Rigid schedules and long work hours also serve as organizational barriers. The conflicts produced by workplace norms and time demands have been well chronicled by scholars such as Hochschild (1989), Schor (1991), Bailyn (1993), and Moen (2003). The term the "politics of time" has been used to describe how employees use their time at work and how employers interpret that use (Rapoport et al., 2002; Sirianni, 1988). Many employers continue to operate under the assumption that the best employee is the one who spends the most time at work. Time at work is equated with employee commitment and productivity. This makes it difficult to offer the single policy that seems to offer the most value to the greatest number of workers, flexible work arrangements. Research suggests that one of the most effective ways to create a family-supportive environment is to offer employees flexibility in the scheduling of work (e.g., flexible work hours, compressed work week; telecommuting) (Allen, 2001; Rodgers, 1993; Thomas & Ganster, 1995). However, work is still primarily conducted in the workplace during a standard set of hours and within the proximity of management (Brewer, 2000). Additionally, even companies that offer flexibility options, typically make them available to only a subset of the population (Brewer). Greater employee control over work scheduling is important in that it has been associated with multiple indicators of quality of life (Thomas & Ganster, 1995). Accordingly, many scholars have recommended that organizations play a larger role in increasing workplace flexibility (e.g., Sirianni, Rapoport et al.; Thompson et al. 1992).

Another related organizational barrier is lack of commitment and support from management. Policies such as flexible work arrangements are difficult to successfully implement without commitment from management and supportive supervisors. As noted by Nord, Fox, Phoenix, and Viano (2002), garnering the support of top management is frequently mentioned as critical to addressing work and family issues. However, support from first-line management is likely to be what is most important when it comes to effective work-family policy implementation and administration. Supervisors may be resistant to enacting flexible work options and make it difficult for employees to utilize the benefit (Allen, 2001; Brewer, 2000; Thompson et al., 1992). Not only do supervisors need to support and effectively manage family-supportive policies, they need to use the benefits themselves. Kossek, Barber, and Winter (1999) found that managerial use is critical to the implementation of family friendly benefits such as flexible schedules. Managers serve as role models to their employees. If managers take advantage of benefits, they send a signal to employees that benefit use is okay.

Perhaps the most challenging organizational barrier is that of corporate/Organization culture, or more specifically work-family culture. Indeed, Levine and Pittinksy (1998) suggested that the biggest obstacle to supporting a more father- and mother-friendly workplace was culture. Briefly, work-family culture refers to "The shared assumptions, beliefs, and values regarding the extent to which an organization supports and values the integration of employees' work and family lives" (p. 394) (Thompson, Beauvais, & Lyness, 1999). Researchers have recognized that even when benefits geared toward helping employees balance work and non work needs do exist within the organization, employees may not use the benefits out of fear that they may jeopardize their career and risk being perceived as less committed to work (Fried, 1998; Lewis, 2001; Nord et al., 2002). If employees do not use the benefits, the effectiveness of family-supportive policies is limited. It should be recognized that obstacles previously discussed, male-based models of work, rigid assumptions concerning the value of face-time at work, and unsupportive supervisors all underlie an organizational culture unlikely to implement and facilitate family-supportive policies. Each of these barriers needs to be eliminated to help develop a family-supportive culture. Thus, as Galinsky, Friedman, and Hernandez (1991) suggested, culture change is an advanced stage in the evolution of an organization moving toward the creation of a family-friendly workplace. In organizations with a family-supportive culture, developing solutions to help employees balance work and family is viewed as integrative, strategic part of doing business.

## 4.3 Limitations

Some of the limitations mentioned below for not having successful organizations.

**Unwilling to invest**, the organization has a limitation with the investment, it has to consider new technology and its advantages, and at the same time with market analysis. Investing into new businesses or development is a long process in complex organizations and that too it should has higher significance for changing the new technology replacing the old one.

**Unwilling to work hard**, the working culture and styles of working in the organization is also a limitation. It is hard to identify the work-process and performance efficiency of the staff in high complex organization like in tightly coupled organizations. And the staff is not willing to take much risk and work hard for better profits due it is tightly coupled. There will be hierarchical differences to come and work together for success.

**Unwilling to change**, the staff and management are used to work with old systems and old technology which have been working for 10 years at least. The management doesn't dare to change to latest and newer versions of the technology and changes in the work-procedures. The change in tightly coupled complex organizations is too difficult to organize and manage.

**Unwilling to take the time**, the organizational management staff doesn't take time to take decisions and shaping the hierarchy in better way and efficient way for better achievements. The toughest part in the management of the organization is the time management. The organization has to face lot of the time issues for finding, implementing the changes into the organization. The organization is with lot of the top management and stakeholders and it is very hard to manage.

**Market risks**, the organization is always connected to the market ups and downs. The newer changes and management is also depends upon the market direction. For example, in the recent recession no single company has recruited employees and no single oil company has ordered for the upgrades and even they hold the running projects from the service providers.

# 5. Technical

The technical solutions available at Onshore CR are sophisticated automation technology, featuring the latest hardware and software technology to provide qualities like user-friendliness, scalability, openness to third-party systems and capability of integration with existing solutions. The latest onshore control system has a possibility to represent the whole offshore platform through its sophisticated technology. The network communicating in between offshore and onshore is fiber-optic communication, the network in between onshore automation systems are MB300 and TCP/IP. ABB is one among these automation technology providers in NCS

## 5.1 Definitions and Abbreviations

Some of the definitions and abbreviations defined below for the technical system and applications

### 5.1.1 Definitions

Some of the useful definitions in technology design area

| | |
|---|---|
| **Alarm** | A signal generated to make an operator aware of a situation that has important consequences and requires prompt action. |
| **Alarm rationalization** | Generally defined to be the process of reviewing process, status and safety signals and determining whether the signals warrant having an alarm associated with it at some limit, deciding upon an appropriate alarm priority, identifying a likely operator response to that alarm, and providing documentation on the rationale. |
| **Control actuator** | The part of the control actuating system that is directly actuated by the Operator, e.g. by applying pressure (EN 894-1). |
| **Dialogue** | Interaction between a user and an interactive system as a sequence of user actions (inputs) and system responses (outputs) to achieve to achieve a goal. |
| **Display** | Device for presenting information that can change with the aim of making things visible. |
| **Effectiveness** | "The accuracy and completeness with which specified users can achieve specified goals in particular environments" (ISO 9241-10). |
| **Efficiency** | "The resources expended in relation to the accuracy and completeness with which users achieve goals" (ISO 9241-10). |
| **Satisfaction** | "The comfort and acceptability of the work system to its users and other people affected by its use" (ISO 9241-10). |
| **Task** | Actions or collections of actions done to carry out a function. |
| **Usability** | "Extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (Source: ISO 9241). |
| **User Interface** | All attributes of an interactive system that provides the information and controls necessary for the user to accomplish specific tasks with interactive system. |

### 5.1.2 Abbreviations:

The abbreviations used for this document is attached at the end as Appendix E

## 5.2 Automation system at Onshore CR

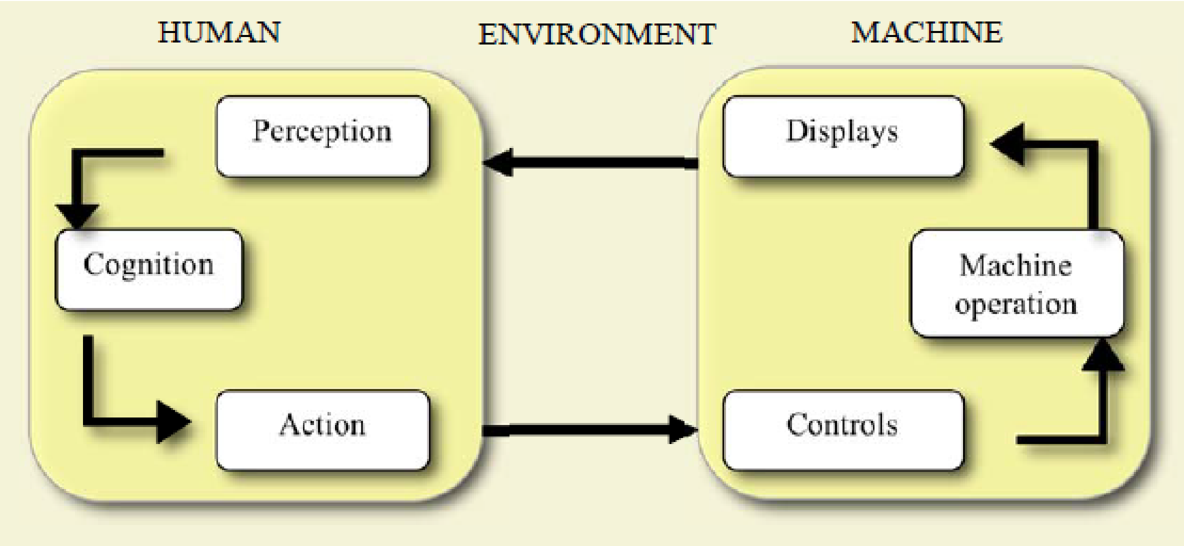
The major occupying technologies in control room are HMI system, network, servers and security systems.

### 5.2.1 Human-Machine Interface system

HMI gives the right information, to the right person, at the right time, in the right format so that they can make the right decisions and implement them. The term "Human Machine Interface" (HMI) includes all attributes of an interactive system (software or hardware) that provide the information and controls necessary for the user to accomplish specific tasks with the interactive system. Specifically, components of the HMI include, but are not limited to:

- Displays/Output devices (visual/audio displays, fixed/dynamic, hardwired buttons, dials on-screen objects to be interacted with, panels/screens)
- Controls/Input devices (physical controls – keyboards, mice, buttons, trackballs and audio controls – voice and software controls – controls on screen)
- Interaction forms (menus, direct manipulation, command language)
- Task aids (overlays on keyboards)
- User Interface support/help and Alarm management

A simple model of Human – Machine – Interaction is shown below.




Humans perceive information from technical systems/machines through one or more of the five senses (vision, hearing, touch, taste, smell), relate it to previous experience and/or values, rules, procedures before making an action (cognition). Actions are effected on the controls of a system (e.g. press a button, foot pedal). The machine/technical system then handles the input according to stored logic. Human – Machine – Interaction is improved if the human operator has a mental model of how the machine/technical system operates and how the process being controlled by it operates. The feedback from the machine to the human operator is then presented by a display (visual, sound, vibration) or combination of displays (sound alarm and on visual display).

To operate offshore equipment from Onshore Operation Center by humans, the interfacing technology should meet the following requirements

- Safe
- Efficient and
- Intelligent remote operations

To meet this, the interface should be designed so that it is:

**Easy to learn**: ensure that operators can be quickly acquainted to the unfamiliar systems, to be able to work with them.

**Easy to use**: easy to explore, efficient, easy to get overview of the system.

**Easy to remember**: so that operators can return to work after a period of spare time/job rotation without having to re-learn everything again.

**Low error frequency/error tolerant**: to avoid operators from making mistakes, and that these errors/ mistakes are not fatal, and to ensure that operators can get back to a safe position.

**Effective**: Ensure that the system is efficient to use, to ensure regularity and optimized production. An interface should provide adequate information to allow rapid overview as well as complete information concerning detailed parameters.

**Comfortable/motivating to use**: the systems should be "motivating" to use, in order to ensure that the operators accept the user interface and fully use its applications and functionality.

The HMI is the main operator interface for the following safety systems:

- ESD incl. blow down
- F&G
- PSD
- Project specific safety systems (HIPPS, Burner Management System etc.)

In addition, the HMI is typically used to interface systems such as:

- PCS and all other SAS subsystems incl. package control systems (ref. NORSOK I-002)
- IMS
- Work Permit System
- 3rd party systems

The HMI is designed to satisfy two main operational modes:

- Normal control and monitoring mode with a proactive role of the operator
- Reactive mode where the operator's attention and actions are triggered by alarms

The HMI provides the operator with an efficient and clear overview of the whole platform facility. The following operator tasks and actions shall be supported by the HMI system:

- Monitor and control of the plant
- Response to situations before the safety systems initiate automatic actions

- Response to dangerous situations if the automatic safety systems do not function as intended
- Evaluation of alarms
- Acknowledgement of alarms
- Identification of deviations from target operating conditions and corrects them.
- Alert of plant personnel
- Verification of correct completion of actions

The main operator interface from where operator actions/commands are performed shall be the windows based operator station screens. Other interfaces will typically be CAP, Large Screen Displays and telecommunication devices. The operator interface (HMI) is designed to simplify rather than complicate operator tasks.

Windows based HMI allows for different user roles and different access rights shall be given to the various roles:

- Operator
- Supervisor
- Engineer
- Maintenance/Support
- Emergency Team
- Onshore/Operation Management

Dependent on the operating philosophy, other user roles/groups might be required and the HMI shall be configurable to allow other user groups to be configured.

### 5.2.2 System Topology at onshore operation center

Onshore operation center has a system topology consists of the following systems to access and monitor and control the operations of offshore platform remotely.

#### 5.2.2.1 Domain controllers

The Domain Controller stores and manages information about user credentials and access rights, both for the users, servers and PC's. It provides the Active Directory service that manages user groups, policies and user access to computers in the domain, which includes user logon, authentication, and access to the directory and shared resources.

#### 5.2.2.2 Aspect Servers

The Aspect Server contains information and configuration about the automation system . It runs the central intelligence in the system, including the aspect directory and other services related to object management, object names and structures, security, etc. Aspect Server supports 1oo2 and 2oo3 redundancy with full function and 1oo3 redundancy without engineering capabilities.

#### 5.2.2.3 Connectivity Servers

The Connectivity Servers provides the connectivity between the Client/Server networks and the Control Networks, including the MB 300 networks through RTA units. Latest automation system supports connectivity towards various process controllers. The connectivity servers run on 1oo2 redundancy.

#### 5.2.2.4 Remote Client Server

The Remote Client Server provides terminal server functionality for connection of remote clients running different workplaces (Operator or Engineering workplaces).

#### 5.2.2.5 Asset Optimization

Asset Optimization brings maintenance management to the operator environment to provide a single window interface for all asset management related operations. This allows plant personnel to collect, compare, and monitor asset data to accurately assess equipment conditions in real time. For maintenance personnel, Asset Optimization provides a default Maintenance Workplace that supports daily maintenance activities in a most efficient way.

The combination of innovative automation architecture plus advanced information technologies, including integrated Field bus solutions, allows Asset Optimization to monitor and optimize all plant assets in real time. This includes field devices, control systems, and automation elements, as well as major assets such as heaters and generators.

Asset Optimization significantly reduces costly production interruptions by enabling predictive maintenance. It records the maintenance history of an asset and identifies potential problems to help avert unscheduled shutdowns, maximize uptime, and operate closer to plant design limits. Plant managers have the opportunity to collect, compare, and monitor data on field devices and larger equipment to accurately assess equipment operating performance in real time. As a result, faltering performance can be uncovered before breakdowns occur, and maintenance can be scheduled accordingly.

When integrated with SMS and e-mail Messaging, Asset Optimization provides a method for sending messages based on alarm and event information to user devices such as:

- Mobile telephones.
- E-mail accounts.
- Pagers.

#### 5.2.2.6 PC, Network and Software Monitoring

The PNSM (PC, Network and Software Monitoring package) provides a set of predefined IT Assets that represent common devices and system processes within automation system (for example printers, computers, switches, and software programs). These IT Assets provide data from the simple (printer out of paper), to the sophisticated (detection of a slow memory leak in a computer). When problems are detected (or anticipated), the programmed software can generate alarms and informing the user about the problem automatically.

#### 5.2.2.7 Remote Data Collector Server

The function of the Remote Data Collector server is to collect data including events and alarms from the control systems and forward them to the offshore Knowledge Manager server with a secure protocol that is easily tunneled through the firewalls. Data collector node is typically configured to record length of 1-2 weeks history of the measured values that can be used to backfill the onshore Knowledge Manager in case it has been unavailable or the communication is stopped. There can be several data collector nodes connected to one onshore Knowledge Manager and data collector nodes can be configured to provide redundancy to each others.

#### 5.2.2.8 Knowledge Manager Server

The function of the Knowledge Manager server is to collect and store process data from the control system and other 3rd party systems. Several plants with each one Remote Data Collector could feed the onshore Knowledge Manager with data. Other tasks are to provide application interfaces for process data extraction including events. Knowledge Manager is also capable to show process graphics, trend and events in a read only mode for users in the Office domain.

#### 5.2.2.9 Management Server

Main purpose of the Management Server is to handle maintenance tasks such as listed below:

- Windows Server Update Services, Microsoft security patches (WSUS)
- Antivirus definition updates, McAfee ePO
- Backup execution. Symantec Image backup of servers and clients

The Management Server is used to control the distribution of updates and patches to system computers.

## 5.3 Information and Communication Technology

The information and communication technology provides the access to the offshore control system remotely. The major communication technology is involving in network communication between onshore systems, between onshore and offshore systems and information technology involving in onshore control room.

### 5.3.1 Network in between onshore systems

The following networks are the main components in the communication technology between onshore control systems. So many network protocols and prototypes are involving in network communication between the networks in onshore control room as explained below.

#### 5.3.1.1 Client/Server Network

The Client/Server network is used for communication between servers, and between client Workplaces and servers. The Client Server Network is a trusted network zone that may not be connected to any outside available connections. It is a private IP network that uses static addresses. The HMI Client Server Network should be made redundant using the RNRP protocol and redundant Ethernet switches.

#### 5.3.1.2 Control Network

The Control Network is a local area network (LAN) optimized for high performance and reliable communication, with predictable response times in real time. The Controllers and Connectivity Servers are connected to the control network. The Control Network is based on Ethernet using the MMS protocol on top of a TCP/IP protocol stack, plus additional services for time distribution, redundancy features, etc. Configuration has redundant Control Network using the RNRP protocol and redundant Ethernet switches. The Controllers connect to the control network via dual build-in network ports.

The Control Network should be keep as isolated as possible from all traffic that does not belong to controller products.

#### 5.3.1.3 MB 300 Network

Advant Master Controllers (MB300 prototype family controllers) are connected to MB 300 Network. The windows based Connectivity servers are connect to MB 300 network via RTA boxes PU410. This type of network prototype is more frequently using and more products are communicating to the control system network.

#### 5.3.1.4 Technical Network

Technical Network will be used for all the operations out of Client/Server such as maintenance etc. Integrated Lights Out is maintenance protocol standard and will be integrated in the technical network. Using this protocol gives full access to maintain and control the server from startup to inside operating system environment. This is a standard network protocol on all servers.

This network is also used by the Knowledge Managers to receive data from the RDC.

#### 5.3.1.5 External Communication Network

The External Communication Network is used for remote login from engineering environment or training system. It will handle 3rd party communications and communication with the Plant Information Network 2 (PIN2).

Also updates such as Microsoft security patches and antivirus definition files will be transported here. The image backup function of the servers and client will be handled in this network. In effect this network relieves the HMI Client Server Network from all traffic that is not strictly needed to operate the plant. This network uses standard TCP/IP protocol in the transport/network layer, and Ethernet as physical media.

#### 5.3.1.6 Plant Information Network 2

The purpose of the onshore Plant Information Network 2 is to facilitate communication from control systems and other systems on the plant to systems at office level. The network is suitable for hosting application servers and a central Process Information Management (PIMS) server managing aggregation of data from technical sub-systems. Typical systems / sub-networks interfaced to a Technical Information Network are:

- Process and Safety control system
- Electro control system
- Electro monitoring
- Vibration / mechanical condition monitoring
- Telecom system

- Other 3rd party systems

The Technical Information Network can be a dedicated single site solution or being a part of an extended plant intranet solution shared by several platforms on a field. This network uses standard TCP/IP protocol in the transport/network layer, and Ethernet as physical media.

#### 5.3.1.7 Third party Networks and Systems

These networks will interface 3rd party equipment and systems to the HMI automation system. Any communication with the HMI Client Server Network or other networks will go through a firewall. These networks use standard TCP/IP protocol in the transport/network layer, and Ethernet as physical media.

#### 5.3.1.8 Thin Client Network (RGS Network)

The Thin Client Network is used for connection between the Thin Clients (in the onshore control room) to the Blade workstations. Remote graphics software (RGS) is used between the workstation and the thin client. This software is compressing and packing the data stream between the workstation and the thin client. The data is also encrypted. The Engineering and SAS topologies have different Thin Client Networks. SAS operator clients uses SAM solution while the Engineering system operator clients not.

### 5.3.2 Network between Onshore and Offshore

The important and sensitive communication technology is involving in the network communication between onshore and offshore. The major communication technology involving is fiber-optic communication and may be some customers are interested with satellite communication. Some of the communication technology is explained below with the case example in North Sea.

#### 5.3.2.1 System Overview

The Backbone Communication system is part of a transmission system between the onshore and offshore platform.

The Backbone Communication System shall comprise of:

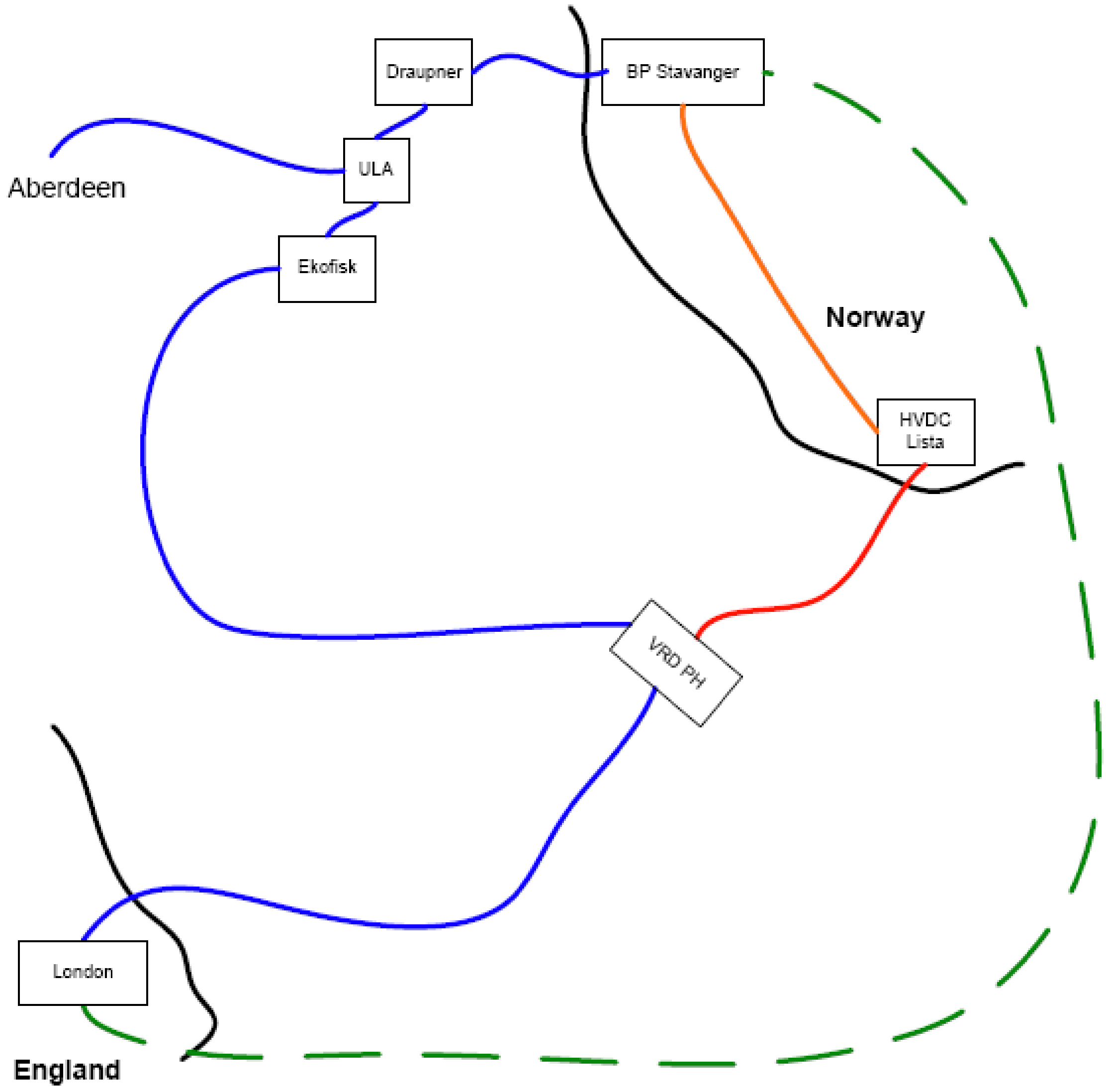
- Dense Wavelength Division Multiplexing (DWDM) transmission equipment at Platform
- DWDM transmission equipment at Onshore.
- Fiber optic cable network at PoP (Point of Presence)

For the case, the general layout of the platforms and fiber optical cables for BP is shown in topology drawing. The blue lines indicate existing North Sea Com cables from Stavanger to England via Valhall, also connecting Ula and Ekofisk. The orange line shows the new connection from Stavanger (Forus) to Lista via leased capacity. The red line indicates the new BP operated cable from Lista to Valhall (PH). The green line indicates an alternative routing from England to BP Stavanger office via a leased connection. Existing communication links from PH to surrounding platforms such as Hod, FN and FS.

The physical fiber optical cable network scope shall include:

- Hook-up at the end points of the cable
- Internal fiber cables at Lista and PH
- Demarcation patch panels and/or fiber terminations
- Offshore fibre cable

#### 5.3.2.2 Topology Drawing in Northsea




#### 5.3.2.3 Submarine Fiber Optical Cable

This fiber has a low loss in the 1550nm band. Low loss is achieved by using pure silica core. ITU-T G.654 fibers can handle higher power levels and have a larger core area. This fiber has been designed for extended long-haul undersea applications.

A transition to an offshore grade fiber cable will be made close to the cellar deck for the final run to the central equipment location. All connections on the submarine cable must be fusion spiced at each end PoP.

### 5.3.3 Information Technology in OOC

The following communicating networks available in the onshore operation center in most of the customer's OOC. This mainly focuses in plant network and communication technology for internal use only. The most communication between the employees and management is through these following systems and networks.

#### 5.3.3.1 Plant Network

Plant network is the network outside from the automation system network. Any communication from plant network to automation system will go through a firewall. These networks use standard TCP/IP protocol in the transport/network layer, and Ethernet as physical media.

The Remote Clients that requires access to the customer automation system will connect through Terminal Server in the Remote Client Server.

#### 5.3.3.2 Computer technology

Communication between people with an increased use of ICT makes it clear that communication and Information technology has huge impact on the following functions:

- Knowledge function
- Social function
- Control function
- Expressive function

#### 5.3.3.3 Telecommunication Systems

The telecom system will consist of several telecom sub-systems, most of these systems are global in nature which means that they cover several objects and requires a common design.

The telecom systems shall be tied together via a communication infrastructure between the platform(s) and to Onshore Operation Center (OOC). This communication infrastructure is part of the telecom systems and needs to be suitable for future expansion and requirements.

Warning and emergency communication lines shall be established to shore via two independent routes using permanent lines. High availability and reliability is required for the network solutions and equipment.

Systems for warning and emergency communication internally on the installations and to other installations, vessels and to onshore shall be established. The requirement shall be covered by the use of PA system, telephones, UHF platform radio and mandatory and general radio.

- PA system for distribution of audio and visual alarms

- Telephones for internal and external telephone service in emergency situations, includes hotlines between onshore and offshore control rooms

- UHF platform radio system for radio communication to and between portable and fixed UHF radios. The system shall handle emergency communication and will be used by emergency response teams. All UHF circuits should be accessed and monitored from OOC.

- Mandatory and general radio for reliable radio communication to ships, helicopters and other platforms and communication means for lifeboats, MOB-boats and life rafts. (GMDSS equipment). Should be accessed from OOC to assist during SAR and maritime operations.

- Data recorder for storing of audio/Video communication in order to recreate and analyze incidents. Should be stores in the OOC.

Detection and monitoring of hazardous situations shall be possible from OOC. Suitable systems to be linked and used, like CCTV, EMS and subsidence detection.

- CCTV for critical area surveillance, supporting acceptable response time (NORSOK requirement; 4 minutes from detection to confirmation) for checking incidents and preventing operators to enter hazardous areas, personnel search in MOB (IR camera) situations, crane CCTV system for equipment handling monitoring. All to be monitored in the OOC to ensure proper remote control and remote operational support.

- EMS for weather observations supporting safe marine, helicopter, SAR&MOB, subsea and crane operations and also transfer of weather observation for weather forecasting services. This should be monitored in separate state-boards in the OOC.

- Subsidence detection supporting platform integrity.

- Oil spill detection monitoring to both offshore and onshore CR for disaster recovery support.

- Personnel tracking and locating of missing persons shall be possible with a system for automatic personnel registration (APRS). All data to be transferred to both offshore and onshore CR for situational awareness during evacuation.

Collision warning and monitoring of safety zones shall be possible. Suitable systems to be used like radar surveillance, AIS, RACON, and VHF/DSC radio communication (VTMS). All the information is to be linked to shore for monitoring and support.

- Radar surveillance for collision monitoring of vessels and drifting objects.
- AIS for collision monitoring of vessels and platform location indication to vessels AIS receiver.

- VHF/DSC radio communication to vessels.

### 5.3.4 Network Security

Network security measures aim at protecting the confidentiality, integrity, and availability of a computer system. This is a complex challenge involving both technical and procedural measures. Providing and managing enterprise-wide network security is a moving and dynamic target, complicated by continuous technical, organizational, political changes, global interconnections, and new business models. [ABB internal document, 2009]

For control systems in particular, the potential impact of an attack includes, for example, violation of regulatory requirements, loss of public confidence, loss of proprietary or confidential information, loss of production, damage to equipment, and endangerment of public or employee safety.

The implementation and maintenance of the network security will be based on the analysis and assessments of customer IT needs, including current and planned network structures and information and control flows, risks of different types of attacks etc.

The security policy for customer will be based on the principle of least privilege and compartmentalization, every user or application will be restricted to access with the minimum rights for the minimum resources necessary to fulfill its purposes. This reduces the possibilities of the attacks on the client/server network and limits the damage in case an intrusion attempt is successful.
Since the technical solution will be installed as a physically separated network, any communication to other networks must be done through firewalls. This is done to ensure that attempted intrusions are detected and stopped.

Almost all automation companies recommend that it is possible to physically isolate the automation system from the office network in the event of an attempted intrusion.

#### 5.3.4.1 Secure access to the Plant network

The security network scheme proposed by one of the automation company is shown below. The details in such a configuration need to be decided in collaboration with customer.

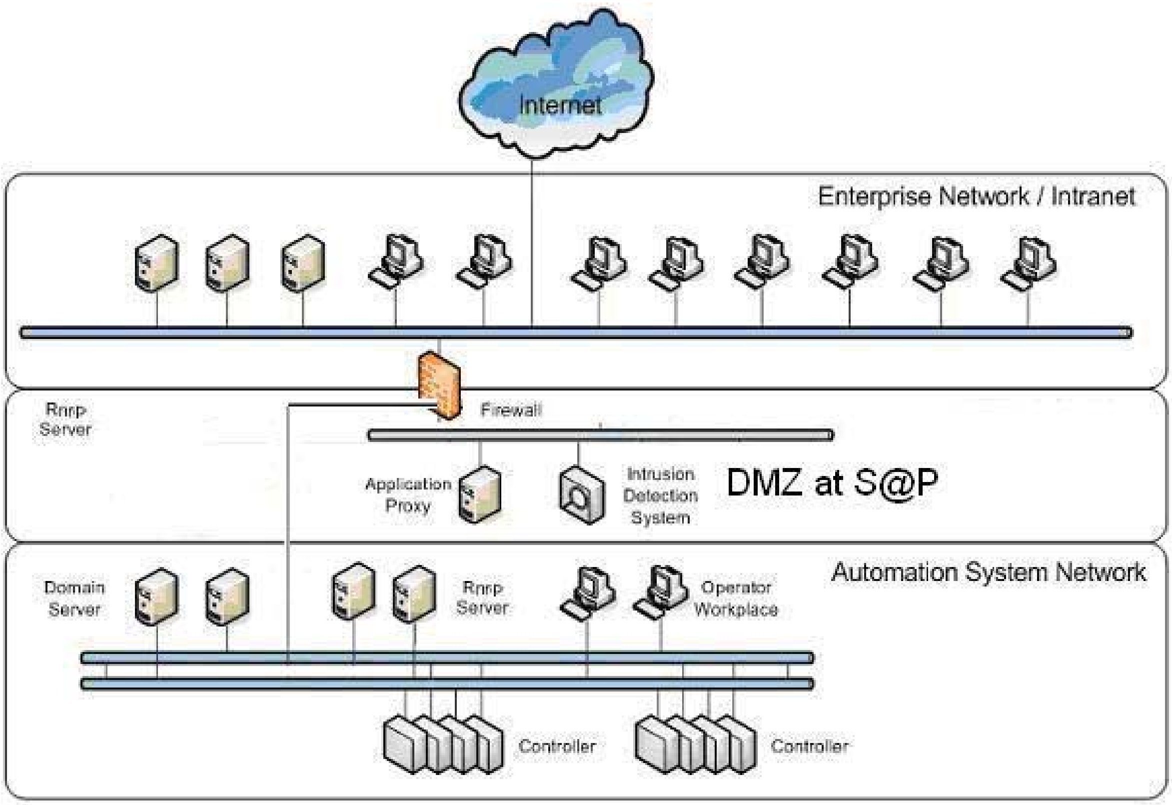



**Figure Security network [ABB, internal document, 2007]**

This network scheme will perform the most complete, flexible and secure scheme provided for customer Client/Server Network access.

There is a demilitarized zone (DMZ) Connected to the firewall in the figure above. The firewall in the Technical network is the boundary with the customer. On the DMZ network, application servers for external access for maintenance are placed, typically with Citrix or MS Terminal server services as applicable. All access to remote client servers on the client/server network is also routed via the DMZ.

For connection to the redundant network the firewalls are made redundant, one per each redundant Client Server Network (primary and secondary). There are 2 firewalls in the proposed solution for any customer.

There won't be direct protocol connections between automation and customer@work. All the information coming to or from the automation system will go through the mentioned DMZ.

#### 5.3.4.2 Protection against intrusions

To ensure that attempted intrusions are detected and stopped, firewalls and DMZ should include intrusion detection systems (IDSes). The advanced firewall provides high-performance intrusion prevention and worm mitigation services through the AIP SSM, or comprehensive malware protection services through the CSC SSM.

It should also be possible to physically isolate the automation system from the office network in the event an attempted intrusion is detected in the DMZ.

#### 5.3.4.3 Remote Services

Connectivity from systems outside the SAS Client Server network is described as Remote Services.

Remote Services could be Remote Desktop or accessing OPC data from automation system to the Office network or 3rd party systems. With Remote Desktop it is possible to get the same functionality as a local Operator Workplace on the Client Server Network from a remote system.

When using Remote Desktop Solution and for security reasons it is possible that some clients/servers will not be able to use remote connection and will just be accessible locally.

## 5.4 Limitations

**Cost-effect,** the technology utilizing in control room is very sensitive, sophisticate and expensive. The organization may think twice for adopting or inviting new technology into the control room operation. It is very costly to provide new or modifying the existing technology, and also it is very dangerous for 24X7 production plants to think about changes.

**Lack of knowledge,** the automation company is responsible for knowledge development and sharing to the technology system in control room. Every automation company has a research team to produce the latest and new technologies for every year. But the new technology has to be trained to the service or projects departments for availability for the service at any time at customer site and it is very hard.

**Opposition for change,** the technology in the control room is used to the operators for long time for successful operation. The operators and the organization are not willing to change the technology every year as per the new development in the automation company. The major concern is the operators are used to one particular technology which they don't want to change for the new technology unless otherwise it is mandatory to change.

**Technical problems,** the technology in the control room is very sophisticated technology in operating the offshore platform. And at the same time, the technology is very complicated to make service and tracing out the problem and make alive the technology in online. That means if any technical problems arrived in the operating the production platform it is very hard to trace the problems and to resolve the issues online (means doing the modifications when the platform is in production phase)

**Conflicts in the standards**, the standards to follow for developing the technology for the operating company is very hard as per lot of standards. Some of them are ISO 9241-8, ISO 11581-1, ISO DIS 11064 -5, EN 954 -1, EN 61310-3, NORSOK. Normally in Norway NORSOK standards are more commonly used for developing the automation technology for the control room, but it differs with some of the ISO standards.

**Conflicts in the technical experts**, the technology is made for successful operation of the tasks and operations designed and programmed in it. The person designing the program may have different technique then other programmer in the same department. When the problem arrives, the developer may not be available and the other person may not understand developer's idea for the particular task and program.

**Conflicts in the technology**, the automation company is responsible for the technology developing for the customer as per their requirements. The particular technology is for particular tasks and operation. The same technology is not suitable for other customer's requirements, but the automation company is able to produce almost same product for other customer and other requirement also. Due to lack of the knowledge as mentioned above.

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# 6. Results, Analysis and Recommendations

The thesis work has been resulted these many observations, best practices and recommendations

## 6.1 Challenges and Best Practices on Common finding

Thesis work has been resulted some challenges and best practices in Onshore Operation Center based on common findings from interviews, survey and observations of Oil & Gas operators. The challenges was due to poor routines related to handling of conflicting messages, errors due to poor quality of information sharing, lack of human resources to check, supervise and correct each other, poor ability to spontaneously adapt to unexpected and demanding emergency situations, lack of redundancy in technical systems and/or human resources, missing warning when an unwanted incident happened, and missing training. To each of these above challenges some recommendations, best practices based on experiences and suggestions.

Thesis work has been resulted some challenges and best practices based on operational experience with different Oil & Gas industries. The challenges identified from them have been related to organizational changes, not enough focus on human safety, not enough focus on employee welfare, not enough focus on training and not enough focus on technical support. Best practices have been related to improved availability of competence when it is needed and improved work processes and improved responsibilities between the organizational levels. These issues are relevant in onshore operations.

Thesis work has been resulted some challenges and best practices based on interviews and discussions that increased safety has not been a clearly stated goal to operate platform onshore. Technology has been prioritized before human and organization in an HTO (Human-Technology-Organization) perspective. Development of work processes, training in cooperation and worker involvement across companies is delayed after implementation of the technology. The organization has not used a methodology to allocate functions between onshore and offshore with a focus on safety. The organization has different work processes and procedures among the well operations these are not standardized. Training and support should have been prioritized more. The use of video equipment has improves communication and collaboration among the employees across onshore and offshore. CRIOP, with the e-operation check-list and suitable scenarios, should be used by the industry to verify and validate co-operation in control rooms between the different actors.

Relevant Challenges and Best Practices Based on Common Findings are listed below:

### 6.1.1 Establish Robust Routines

In the oil & gas industry it was observed that routines were not robust enough. There were weaknesses related to sharing of safety information and weaknesses when there was mismatch between information given by the technical system and messages from the operators. It is important to make clear what should be done when the system and operators are giving conflicting messages. This is especially important if it the situation is time critical and there is no time to double-check the messages. Serious incidents and accidents could be traced to poor quality in developing and maintaining routines.

a) Routines need to be unambiguous and understood by all operators. Ideally the routines should be developed and refined in cooperation with the operators to ensure robust and resilient routines.

b) Routines about how to handle conflicting information from operators vs. the technical systems are important to establish. It is also important that all operators working with the onshore operating system have similar and common under-standing of how these incidents should be handled in efficient manner with respective to offshore systems.

c) Routines for sharing safety information and incidents should be established, both inside the company and between companies. Incidents and safety information should be exploited to improve the routines.

### 6.1.2 Establish Robust and Rich Systems and Routines for Information Sharing

It was observed that routines and systems for information sharing were not good enough. Serious incidents and accidents could be traced to the quality in communication channels, redundancy in communication channels or in routines for use.

a) The communication channels must be of good quality and free of noise and interferences.

b) Information should be able to be double checked by the receiver when the message is critical, or when it may be difficult to understand the message.

c) To ensure redundancy in communication, information should be communicated as rich information, sent and received in parallel by different medias (sound, pictures and indicators) in several channels.

d) To create common situational awareness, all the control room operators must have possibilities to share and see the same information.

e) Changes of the communication system (temporary or permanent) need to be handled with great caution. Changes resulting in poorer capacity in the communication system should be avoided.

f) It is important to have defined service level in the communication channels and alternative communication media. There should be established a defined Service Level Agreement (SLA) related to stability of communication.

### 6.1.3 Analyze High Workload Situations to Avoid Safety Critical Incidents

Onshore operations and transferring tasks to other sites also means change in the tasks or responsibilities. In the beginning it may be difficult to know exactly how many tasks can be handled in the onshore control room during a crisis or unwanted incident. Experiences show that high workload and fatigue could lead to severe incidents.

a) Situations of simultaneous change of tasks and a raise in workload should be avoided or handled with great care.

b) Random peaks or stress endured over long time can lead to operator's limits for high workload is exceeded. These situations should be avoided by performing workload analysis, scenario analysis or by extensive training. If the control room operators have possibilities to regulate their workload themselves, it is important that this is communicated to them as an important safety issue.

c) High workload may affect the use of routines negatively and sometimes routines are totally avoided. Such issues need to be identified and resolved with the operators.

### 6.1.4 The Ability to be Flexible and to Improvise is Important to Safety.

The ability to be flexible and improvise is important to ensure that unexpected situations are handled. The two most important issues to accomplish this are cross-disciplinary knowledge and to know what other experts are needed to resolve the issue. A prerequisite is that experts are available and can be contacted if needed. The operators are coordinating and using knowledge and experts related to the particular situation in a highly effective manner and often by improvising, even though the operators are not specialists. Some important lessons from the onshore operators are given in the following.

a) The control room operator's ability to improvise when unexpected incidents occur should be emphasized. To be able to improvise, the operators must master the technical systems and have comprehension for other operator's tasks and the whole picture of activities going on. They must be able to get an overview of the situation, use other operator's knowledge, cooperate and coordinate, be creative and dare to make decisions. Improvisation is a skill to be developed and sustained by good training.

b) In some situations it may be appropriate to let the control room operator decide how to use procedures. Examples of this are when procedures are used as guidance in tasks or as verification afterwards. Or when it can be more effective to delegate tasks based on the situation rather than based on pre-defined rules.

### 6.1.5 Redundancy in Technical Systems and in Human Resources Should Be Established.

Lack of redundancy is a returning element in the Oil & Gas industries. Either as lack of technical solutions capable of taking over if something fails, or that operators are alone in executing their tasks and other people are not present to spot if something is wrong. This represents an essential lack of barriers, which makes the organizations vulnerable for single errors, either in the systems or by single persons. Redundancy in technical systems or in humans will help sustain barriers and reduce errors. A combination of redundancy in systems or humans may give defense-in-depth with barriers both taking care of active and latent faults

a) Redundancy both in human and technical systems should be established as well as warnings if redundancy is missing.

b) It must be established a culture that encourages utilization of human redundancy and resilience. The operators must be trained to correct, support and assist each other when needed. Operators must understand the importance of reporting suspicious situations, as well as the importance of follow each other's work. It must be a culture for giving each other corrections and comments, both positively and negatively to improve resilience.

### 6.1.6 Build Redundancy by the Remote System's Active Warning Functions and Alarms.

Active warning functions means functions that is automatically activated, or functions that is activated by an operator and is warning other operators through the technical system. It is highly important that active warning systems are installed to build redundancy, in addition to having operators. It is risky to only rely on operators to detect and prevent all dangerous situations. Good and adequate warnings and alarms are important for the control room operators to be attentive of situations in time. There were several incidents related to missing "active warnings".

a) The remote system needs to be able to warn if something risky is about to happen. It must be able to give instantly warnings both thorough sound and light. Redundancy in reporting is important. However, without stressing the operators.

b) It is important that the remote operation system is giving clear indications about the actual status and is signaling if safety critical functions are lost.

### 6.1.7 Continuous Education and Sharing of Experiences to Increase Resilience in Onshore Operations.

New systems will require new and maybe challenging ways of working for the operators. Operators will use much time just to handle the new systems, and they are more focused on their own tasks than situational awareness e.g. the sum of actions happening in the central. Until they feel safe and comfortable using the new systems it will most likely occur situations, which is difficult to gain overview of and to handle correctly. It is important to assure adequate education in new technical systems. Also, existing systems may need some repeated education as some functions are seldom used or the operators develop a practice not according to the intentions.

a) When new systems are installed, focus has to be placed in education and possibilities to gain experience. Both the employer and the operator should be able to initiate education.

b) It is important to give education in routines designed to correct shortcoming in the remote operating system. Situations where the system is not working may occur, and correct operation is completely depending on the operators. It is therefore important that such routines are made and understood.

c) When operators are performing critical tasks normally not used, training and education should be given before performing them.

d) The training of operators should address the possibility to build up common situation awareness among all the involved operators.

### 6.1.8 Focus on the organizational challenges in addition to technology.

Most of the organizations have been given technology as higher priority than any other parameter in HTO perspective. Especially complex organizations like oil & gas industries not advised to do so. Focus on organization and human factors has to be considered in each and every phase of design and implementation in complex organizations.

a) Customer has to improve cooperation between the levels in the organization. The change process should involve the affected organizations, and participants from the different levels should be involved to ensure that all stake-holders are involved in good participatory processes. The change processes must involve the important stakeholders, and management must take responsibility. The benefits of the changes must be highlighted. [Kotter, 1996] is a key reference to help guide the change process.

b) Human factors in the complex organizations are more sensitive to the goals and achievements of the organization. The onshore operations will involve lot of human behavioral effects and characteristics of the humans working on the system. Customer has to focus more on human factors from the design phase and as well as the whole life time of the system.

### 6.1.9 Operator Training must not be ignored.

Operator Training Simulator (OTS)

By using an Operator Training Simulator (OTS) solution, operators can learn to master the process in a safe and realistic environment.

The OTS will be used to train, certify, and re-certify operations personnel to proficiently operate the facility. The Plant Overview, Process Description, Process Risk Area and Operating Philosophy shall be as in the running simulator system. It provides a smoother and less problematic start-up as operational instructions and procedures can be tested properly before implementation.

The OTS shall provide an identical representation of the operating process using the actual operator interface, consoles, graphics and keyboards.

Typical standard OTS functions:

- Transfer I/O between controllers and simulator model
- Simulation of HW-module and I/O channel failures
- Bump less Freeze and Resume of simulation
- Speed to run the process faster or slower
- Save and Load of Initial Conditions (ICs)
- Save and Load of Snapshots (cyclic save as well as manually)
- Reload alarm/event and trends when loading IC/Snapshots
- Time synchronization of simulated system time.

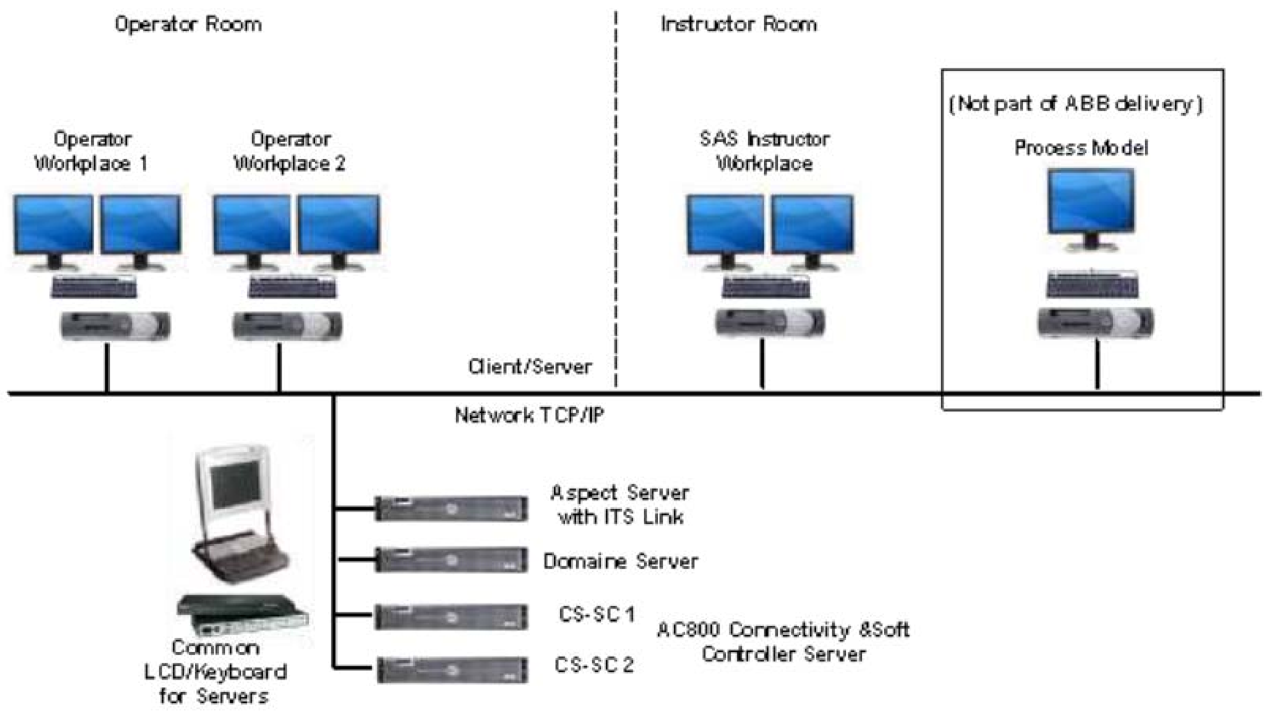


Figure Typical Operator Training Simulator topology [ABB internal study document, 2009]

Operator Trainees shall learn how to start-up the process, operate it under normal operating conditions, shutdown the process, handle malfunctions and process disturbances, respond to infrequent emergencies, and to meet and maintain product quality standards. The existing Process Model shall be used.

In addition to the normal operator training exercises, the OTS is an important tool for preparing operators and other relevant personnel for the transition between the stages. By training on predefined scenarios the personnel will be better suited for the tasks relevant for the different stages. Typically, scenarios where tasks/responsibilities etc. are split between onshore and offshore, simulator training will be of great importance to a successful transition from one stage to another.

All aspects of operation of the OTS and associated software procedures by the instructor and operator shall be covered during the training course so as to get familiarized with the functionality and operation of the facility.

a) There must be a focus on training and continuous support/training to ensure that the new technology and routines are used as planned. There must be allocated enough resources to training and continuous support during operations, it is however important to allocate resources at the initial phase when new work processes are implemented.

### 6.1.10 Technical support becomes critical due to the increased importance of technology

The technology using in the onshore operation center is more sophisticated and complicated system. Regular maintenance and verifying the hardware and software components is more important in complex situations. There should be always some regular verifying agency should be assigned.

- The routines related to technical support must be clearly defined related to responsibility and service levels. A clearly defined SLA (Service Level Agreement) should be specified related to all technical components

#### 6.1.11 Improved availability of competence when it is needed.

In general more uniform knowledge and higher availability of expert knowledge across the institutions, because teleconferencing and remote systems are used much more. Focus on establishing a competence network, with clear responsibility and availability to be used when needed. The competence network should have defined availability and response intervals to be able to aid in an emergency.

Increase of competence at local institutions. Experts are more easily available, leading to increased local knowledge and competence in areas where this is relevant.

- Improved work processes and improved responsibilities between the organizational levels. (Geographical distance is no longer a barrier to improved workflow.)

- Decrease of travel expenses, and decrease of stress related to travels

## 6.2 Relevant Challenges and Best Practice from Company X

Onshore operations within the Oil & Gas operations have been implemented by Company X, using Integrate Operations (IO) and Information Technology (IT) to support cooperation and problem solving in a geographically dispersed environment.

### 6.2.1 Increased Resilience or Increased Safety has not been an Initial and Major Goal

Increased resilience or increased safety has not been a clearly stated goal to implement onshore operations. This should be corrected. To improve resilience, it is important that the whole organization has a common focus on both issues. There seems it is a great deal of complacency related to the implementation of new technology used in onshore operations.

### 6.2.2 Technology has been prioritized then Human and Organization in an HTO Perspective

Using an HTO (Human, technology and organization) perspective when onshore operations are discussed and implemented, I have observed that the focus is on technology. Safety barriers and issues related to organization and human is discussed later. Development of work processes, training in cooperation and worker involvement across companies is delayed after the technology is chosen and partly implemented.

However onshore operations are affecting all aspects of HTO, there is increased use of technology in daily operation, but also new ways of working and structuring the organization. Therefore all aspects of HTO are important to consider in work with onshore operations.

Experiences from fields which have already implemented onshore operation showed that it is essential to develop work processes early and in parallel with technological solutions to gain good results in cooperation and use of control rooms. Still there is low focus on developing work processes early and across locations. It is therefore highly recommended that work processes and work practice are made and implemented early in the process, and in parallel with technology.

### 6.2.3 Structured Methodology to Allocate Functions should have been used

The organization has not used a common methodology to allocate functions between onshore and offshore with a focus on resilience and safety. The methodology CORD, [HFC, 2006], has been developed to do this. Important issues could be clear and precise responsibility between onshore and offshore facilities, or clear and precise responsibility between different firms.

### 6.2.4 Organizational Changes and Necessary Standardization has not been Performed

The organization has different work processes and procedures among the drilling platforms (rigs). This is a challenge related to increase efficiency and a challenge related to the establishment of common situational awareness if onshore operations are going to be performed of several platforms. Standardization could reduce resilience across the different drilling platforms or rigs. The management should prioritize to standardize the different work processes across the different platforms.

The management should change the organizational structures due to the implementation of onshore operations. This needs planning and good co-opting procedures.

### 6.2.5 Training and Support should have been prioritized more

During the implementation process of the onshore center it seems few resources had been used to training in advance and few resources had been reserved to support during the initial phases. The project should have been planned with more resources allocated to training, and more resources allocated to support during the initial phases.

### 6.2.6 A Structured Methodology to Verify Solutions should have been used earlier

CRIOP is a methodology to verify and validate the ability of a control center to operate safely. It considers all aspects of HTO and also considers cooperation in onshore operations. CRIOP is based on HF standards such as ISO-11064.

CRIOP was often not used in the aspects of cooperation, leading to low focus on integrating personnel and experts in different locations and leading to fragmented knowledge between different actors that should cooperate.

It is therefore important to point out that CRIOP, with the e-operation checklist and suitable scenarios should be used by the industry to verify and validate cooperation in control rooms between the different actors.

In general it was found that CRIOP and HF analyses often was performed to late in projects, making it difficult to get acceptance for changes in design. By doing CRIOP late, it is more costly to make changes and it is difficult to get acceptance for the changes, although the changes may be important to safety and resilience. Making such analyses at the right time, maybe earlier in the design process, is therefore recommended to get optimal design regarding all aspects of HTO.

#### 6.2.7 Video Conferencing has Improved Communication and Collaboration

The use of video equipment has reduced travel cost and enabled better communication among a broader basis of employees which has increased common under-standing and improved communication and collaboration among the employees across onshore and offshore.

## 6.3 Recommendations

### 6.3.1 Recommendations during implementation of onshore operation center

Thesis work result is recommending few steps to increase resilience in onshore operations. The methodology is based on experience from different organizations, suggestions on identified common challenges and common best practice related to onshore control room.

All major (and minor) changes must be planned, and the implementation process must focus on Technology, Organization and Work processes in parallel. The implementation process should be based on the steps suggested by [Kotter, 1996] to ensure good co-opting processes, such as:

- **Developing a motivating vision and strategy**, e.g. establish a vision that is relevant and communicating the change vision among all the participants. Improved safety and resilience should be a part of the vision. Establish a sense of urgency among the participants in the organization and in cooperating organizations. Focusing on improved safety, resilience as one result of onshore operations, to ensure that resilience is integrated in the project implementation.

- **Creating a Guiding Coalition,** involving management and key stakeholders that can influence and sustain the result. Management and employees must participate both within the firm and between different organizations. Empowering broad-based actions, to ensure that among other things - work processes are developed together with the users

- **Develop work processes early and in parallel with technological solutions**. This is important to gain good results in cooperation and use of control rooms. It is therefore highly recommended that work processes and work practice are made and implemented early in the process, and in parallel with technology

- **The function allocation should focus on safety,** A structured methodology to allocate functions between onshore and offshore to improve safety and increase resilience should be used. Best proposes to use CORD, as in [HFC, 2006].

- **Establish redundancy in technical systems and/or human resources**, as well as warnings if redundancy is missing should be accomplished. Also establish a culture that encourages use of human redundancy.

- **Use characteristics of HRO in design of onshore operations.** It is important to focus on both organizational redundancy and adaptability. Suggested elements from HRO (High Reliability Organization) to focus on are: common safety goals, cooperation in change processes, clear responsibilities, technical and cultural aspects of communication, decisions in critical situations, routines and procedures for common work (applied across company borders), common procedures and processes for readiness

- **Rich and diverse alarms should be utilized.** Focus on the onshore operating system's active warning functions. The system must warn if something risky happens and be able to give accurate, instantly and diverse warnings and signal if safety critical functions are lost.

- **Provide rich information.** The information sent must be rich and in real time, and available to all operators to encourage a practice for double-checking information.

- **Generating short-term wins**, document the benefits, consolidating the gains and producing more change and anchoring new approach in the culture.

- **Focus on training and support the operator's ability to be flexible and to improvise,** Make satisfactory procedures for continuous education and sharing of experience. Training should include possibilities to build up situation awareness, and correct shortcoming in the onshore operating system and new systems. On the job training should be given when tasks is seldom performed. Both the employer and the employees should be able to initiate education. It is also important that the operators have the ability to improvise. Important elements in improvisation is to focus on the operator's ability to be creative, master the technical systems and understanding of other operator's tasks, as well as the ability to coordinate, cooperate, make decisions and get overview of the situation.

- **The solutions should be validated and verified by exploration of safety related scenarios,** A structured methodology to discuss and explore key safety cases involving onshore and offshore should be used. The safety cases should be chosen to improve safety and increase resilience. Exploration of key safety cases should improve organizational learning among the cooperating organizations. Best proposes to use CRIOP, which has been used to explore safety cases/safety scenarios in the Oil and Gas industry.

    - **CRIOP and/or HF analyses must be performed early in the design process.** Such an early focus makes it easier to get acceptance for changes in design, changes important for safety and resilience.

    - **Train on conflicting messages.** Make routines covering conflicting messages given from the system and the control room, and assure that all operators working with the remote operation system have similar and common understanding of such incidents.

### 6.3.2 Recommendations during operating onshore operating center

- **Establish a competence network in operations**, with clear responsibility and availability to be present when needed. The competence network should have defined availability and response intervals to be able to aid in an emergency.

- **Establish routines and systems to share information and incidents**. Routines need to be unambiguous and understood by all operators. The routines must cover sharing safety information and incidents with all involved.

- **Changes in communications systems must especially be planned.** Changes especially on the communication system need to be handled with greater caution. Good quality, stability and coverage are important.

- **Avoid high work load/fatigue.** To avoid safety critical incidents it is important to focus on avoiding incidents giving too high work load and fatigue, both be-cause of local peaks of work and long time stress as well as simultaneous change of tasks and a raise in work load.

## 6.4 Opportunities / Expected benefits

This Section is a summary of areas which typically gives benefits from successful implementation of solutions for the challenges, risks. Based upon earlier experiences the investments to organize the infrastructure are paid back in few months with main contribution from production optimization and increased availability.

However, the OPEX side is also believed to give good benefits but there are fewer examples where the reader compare an optimally operated offshore field with one combined with onshore operation. Optimization of administrative tasks and a good maintenance strategy is believed to give these benefits.

The expected financial benefits can be divided into:

- Production optimization

- Availability

In general technology does not give the benefits alone – it is an enabler for new work process and methods.

### 6.4.1 Production optimization

By introducing closer cooperation between the reservoir engineers, production engineers, process engineers and operation both onshore and offshore there are documented benefits. It is vital to have the same data available and collaboration facilities in place to allow for close cooperation. Important topics which often gives good results:

- Same data available onshore and offshore at good quality

- Common view targeted at moving from analysis to decision focus in daily planning meetings.
- Short term production optimization
- Capacity utilization
- Process tuning and stabilization
- Start-up of wells

### 6.4.2 Availability

By introducing integrated operations in the offshore platform operation the availability of the system and human resources are great. The higher availability factor leads to the higher production and higher business. The following advantages are due to availability.

- Important topics which often give good results, to keep uptime to a maximum some few main topics are general:
- Identify production and safety critical equipment and apply proper maintenance strategy, i.e. have redundancy or detect errors in time to repair before failure.
- Performance monitoring in order to push the production limits safely as well as for maintenance planning (condition based).
- Maintenance stops to a minimum: Turnaround planning, opportunistic planning, condition based maintenance, optimized logistics.
- Remote access to maintenance and monitoring systems for assistance and quick problem solving.

## 6.5 Further Studies

In order to conduct the further studies from this research, the gathering of information from perspectives of management through onshore control center design and improvements. Besides, the investment criteria might also be included to support the concepts in business point of views. The information for the further studies can be possible with different organizations and different geographical areas to cover the overall designs and improvements of control room. The technology improvements has no end, it has wide range of improvements always. And the organizational design can be done with interviewing different complex organizations not only in oil and gas business. The collection might be performed by questionnaire handling and interviewing to collect qualitative type of information.

## 6.6 Discussion & Analysis

In this section discussion and analyzing the interviews and questionnaire results from the responsible persons in the respective field of Company X and Company Y

The most important findings in the survey about organization aspects were that onshore operation appears to contribute to increased safety, improved working conditions and a better development process. The organizational factors involves in the onshore operation center is mainly the roles and responsibilities of the operators. There is no difference in operating the platform from onshore or offshore, the platform is same but they are geographically separated. The roles and responsibilities of the operators both in offshore and onshore are same. As per understanding the operator's responsibilities are sharable but not all the time. Every operator has their own responsibilities and conditions to operate the plant, at the same time every operator should have idea of the other operator's responsibilities for any emergencies. The major motivation for the operator is remuneration for the job, training and providing safety standards as per interview. In general operators will communicate through video communication, satellite radio, PA between offshore and onshore.

The important findings about technical aspects were the new operator stations and old operator station are running now at offshore platform. The operation is something different from old and new systems. The younger generation people are interested with new systems, but the experienced operators are still interesting with old, due they are used to it for better operations on platform. The regular windows operating system and regular keyboard and mouse make some difference in the operating times and tasks. The control system in the central operation is same from offshore and onshore. Technically the onshore operation is exactly same as offshore operations. The technology will be changing every year for sophisticated technology. The 800xA system (latest technology) from ABB also going for newer revisions every year, that makes the customer to think for higher redundancy and higher performance. The controllers controlling the whole platform operation is at the higher priority as per technical point of view. In the early days used LCD monitors and Projectors, now it is becoming still lot of new technologies are available at the market. So, at some point we have to use some technology at higher end at that time, as per interview with BP and ABB personnel.

The other important findings are more focus about the facilities in the offshore and onshore in human factors perspective. The major concern is human safety and environmental effect from human behavior. Normally the offshore operators will have 2 weeks work and 4 weeks holidays. The mental condition of the operator before and after the vacation will be too relaxed and not in a good condition to take responsibilities if any emergency. But in onshore operation center is flexible for shifts like morning, afternoon, evening or night shifts. There are no such conditions like 2 weeks work and 4 weeks off in onshore. Almost all aspects in the onshore and offshore operations are same except very few changes. The decisions and work procedures of the plant operation will be instructed from the plant supervisor from offshore. There is no separate responsible person in onshore to supervise the operations from onshore operation center. The human behavior is also depends upon the age, attitude, education background, safety attitude, physical ability, family situations, financial situations and interest on the job doing.

The interview results and discussion is more restricted to the customer to customer. With respect to the limitations of time and availability this study is restricted to Company X operation center, organization culture and barriers.

## 6.7 Conclusion

The purpose of this thesis has been to identify the factors influences the operating of onshore control room, best practices from the companies, recommendations from the experts and solutions if any.

There are several reasons why onshore control rooms are implemented into business and industrial sections. However, one of the major purposes considered in most of the organizations is to increase the safety, business and production performance as well as business profits. Nowadays, most business strategies are set to reduce cost, increase productivity, and improve product quality. The importance of ergonomics and usability are realized in most fields of business and industrial sections. However, the organization's lack of actual understanding for the knowledge implementation, which makes the investments in design and improvement costless to the operations. Very often, cost is the most significant concern in business perspectives. Usability and ergonomics are mostly ignored for the purpose of cost reduction with the misleading idea from the executives that operators should be able to adapt themselves to fit the existing control system. In reality, instead of being reasons in costs increment, implementation of usability and ergonomics take parts in reducing the operation cost. They are also supporting factors for the system requirement optimizations, which prevent the business operations from investments in unnecessary and over-demanded technologies for functions in control centers.

The organization has several reasons for affecting the onshore control room operation. However, one of the major significant concerns is its culture and barriers to affect the performance of onshore control room. Every organization has its won culture and operating rules and conditions towards employees and business and also the barriers to control. The organization hierarchies will affect on control room as well as in the decision making for the control room. The welfare and social commitment towards the employees has more significance from organization point of view for performance from staff. And in final it is all cost effective for the organization for any changes in the organization or to make decision bout welfare. The top management and stakeholders are normally doesn't show much interest for developing the facilities and standards for the staff as cost effective. These are the some of organizational effects on the control room operations and performance.

The technology has several reasons for affecting onshore control room operations. Mostly the technical problems, lack of knowledge, not ready to face strange problems, and significantly the organizational effects on technology. The customer is mostly willing to choose the best operating control system rather than new or old. The control system is more cost effect for the organizations to adopt new and latest. The older staff and new staff in the control room have different opinions on the new and old control system. The technology influences the toughest challenges and risky operation in the control room, thereby the successful operation is matters towards offshore platform operation.

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# Appendices

## Appendix A: Interview with Onshore Operator

**Interview Questions:**

1. What has given you inspirations in operating process/production remotely?
2. What are the standard criteria in operating a control system remotely?
3. What are the major criteria in control centers design and improvement?
4. Could you describe your working processes here?
5. What is motivation to operate offshore platform remotely?
6. What are the operator's perspectives through onshore control room design and improvement?
7. Whether the new operator station is able operate smoothly?
8. Did you feel convenient with Reuse library at onshore operation center?
9. Do you feel convenient with the buildings and facilities in onshore OC?
10. What is your working timings?
11. Whether working conditions and workplace is up to the standards?
12. What do you feel about the work timings in onshore operation center?

## Appendix B: Interview with BP personnel

**Interview Questions:**

1. What are the organization factors will influence the onshore CR operations?
2. How do you motivate the operators towards the organization goals?
3. How do you motivate/train the operators for the organization culture?
4. How do you define the organization culture in your organization?
5. What is the workflow procedure in onshore CR?
6. What are the factors you consider to choose the operators for onshore CR?
7. What are the basic requirements for the operators in organization point of view??
8. What are the characteristics of the operators you are expecting for onshore CR operations?
9. What is frequency do you call for meeting with operators?
10. How do you communicate any organization decision on operations?
11. Do you organize any social or cultural events with operators? If so, how frequent?
12. How the organizational barriers will affect the performance of onshore operation?
13. What is the communication channel using between onshore and offshore?
14. What are the major concerns in building onshore operation center?
15. How you perceive through ergonomics application in onshore operation centers?
16. How do operators perceive through ergonomics application in onshore operation centers?
17. What are the criteria that you use in choosing suitable technologies for onshore control operation?
18. Can you describe the significances of simulators to onshore control center, if any?
19. What are the environmental issues in onshore CR operation according to your perspective?
20. What are the factors that could affect the operator's performances in technical as well as organization?
21. How the usability of control system in onshore CR can be improved in your perspective?
22. How organizational ethics and procedures will affect the performance of operators?

23. What are the communication channels in between operators and organization?

24. What is the major difference between CR operation in offshore and onshore?

## Appendix C: Interview with Control System Designer

**Interview Questions:**

1. What are the technical difficulties to operate the whole platform from remote?
2. Does the control system functionality at onshore is fulfilling your needs?
3. What is the future plan with onshore CR, and what is the achievability with it?
4. Does the operation from onshore gives the full control of platform?
5. Does the whole platform is able to operate from onshore?
6. What did you taken consideration to design the control system?
7. What are the technical requirements for the design of control system for customer?
8. What is your main goal to achieve in design of control system?
9. Did you find any difficulty in design for this customer?
10. Whether the customer has to involve in the design phase or not?
11. How did you convince customer with the designed control system?
12. How do you choose the control system and products as per the customer requirement?
13. Did you considered ergonomics into the control system design?
14. Did you taken consideration of customer security and privacy in control system design?
15. Which third party devices used for network security from customer?
16. Whether Reuse library of new operator station is acceptable by operators and customer?
17. Do you have good plan to reduce the technical delays in the process update in system?
18. How frequent did you get call from customer about service?
19. How frequent you do maintenance programs on servers and clients at onshore OC?
20. Is it possible to load the latest revisions online?
21. Which standards you have taken into consideration for onshore operation center design?
22. What is the role of customer about deciding the standards to use for the project?

# Appendix D: Questionnaire

**Section 1: General information**

Please check in ☑ to the given box according to your information.

1. Gender:

   ☐Male ☐Female

2. Age (in years):

   ☐ 25 or younger ☐26 to 35 ☐36 to 45 ☐46 to 55 ☐56 or older

3. Education:

   ☐ High school ☐ Bachelor ☐ Master ☐ Doctoral

4. Your organization's operational characteristics:

   ☐ Industrial/Manufacturing ☐ Public Utilities ☐ Government sectors ☐ Others, describe….

5. Position:

   ☐ Plant Operator/Worker ☐ Control room operator ☐ Design/Maintenance
   ☐ Management ☐ Administration ☐ Executive

6. Work experience in the current position:

   ☐ Less than 1 year ☐ From 1 up to 2 years ☐ From 2 up to 5 years ☐5 years or more

7. Average working time per week:

   ☐ Less than 20 hrs/week ☐20 hrs/week (half time) ☐ From 20 to 39 hrs/week
   ☐40 hrs/week (full time) ☐ More than 40 hrs/week ☐ Other, describe ……..……

8. Your work shift (can choose more than one):

   ☐ Morning ☐ Afternoon ☐ Evening ☐ Night

9. Onshore control room building structure:

   ☐ Excellent ☐ Very Good ☐ Moderate ☐ Below Average

10. Do you know the escape routes if any emergency occurs:

    ☐ Yes ☐ No ☐ Not Applicable

11. Have you been simulated with emergency fire alarm in the building?

☐ Yes ☐ No ☐ Not Applicable

12. How do you come to the work?

☐ Own Car ☐ Own Cycle ☐ Public transport ☐ Company transport

13. How do you rate the facilities at onshore CR?

☐Excellent ☐ Very Good ☐ Moderate ☐ Below Average

14. Do you have any external disturbances in the onshore control room?

☐ Yes ☐ No ☐ Not Applicable

**Section 2: Quality of Work**

Please check ☑ into the given box according to your agreement.

1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = strongly agree

| ***Considerations at Work:*** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|
| You have health concern in daily life. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You enjoy with your work. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You feel stress from your work. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You do exercises as one of your routine. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You feel fresh before work every day. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You feel fresh after work every day. | ☐ | ☐ | ☐ | ☐ | ☐ |

***Job Function:***

| | | | | | |
|---|---|---|---|---|---|
| You understand the system that you are controlling. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You feel challenge with your work. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You are satisfied with your working time. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You have too many responsibilities in work. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You are working for a long time at the same position. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You have support from the other divisions when you need. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You have problem in communications between departments. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You have enough rest between shifts. | ☐ | ☐ | ☐ | ☐ | ☐ |

***Ergonomics at Work:***

| | | | | | |
|---|---|---|---|---|---|
| You feel that your work cause health problem to you. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You can observe the monitoring display clearly. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You sometimes have eyes problem while monitoring. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You understand the functions of the monitoring system. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You understand functions of your working devices | ☐ | ☐ | ☐ | ☐ | ☐ |
| The facilities in your workplace support the comfort of your body. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You can use the current controlling system efficiently. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You have risk in having accidents from your workplace. | ☐ | ☐ | ☐ | ☐ | ☐ |

***Efficiency of Current system:***

| | | | | | |
|---|---|---|---|---|---|
| The monitoring system can display status of the whole system. | ☐ | ☐ | ☐ | ☐ | ☐ |
| The facilities in your workplace supports with abnormal situations. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You recognize all of the alarms that report abnormal situations. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You understand how to response with all abnormal situations | ☐ | ☐ | ☐ | ☐ | ☐ |
| You feel too excite when abnormal situations occur. | ☐ | ☐ | ☐ | ☐ | ☐ |
| The technology of the current controlling system is so advanced | ☐ | ☐ | ☐ | ☐ | ☐ |

***Learning and Self-Development:***

| | | | | | |
|---|---|---|---|---|---|
| Your beginning knowledge has been enough for your work. | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | | | | |
|---|---|---|---|---|---|
| You learn and develop yourself during your work. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You can be a part of the controlling system development. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You can be a part of your organization's operation development. | ☐ | ☐ | ☐ | ☐ | ☐ |
| You have support and opportunities from your organization for Self-development. | ☐ | ☐ | ☐ | ☐ | ☐ |

***Macro perspective in Work environment:***

| | | | | | |
|---|---|---|---|---|---|
| Environmental problems are significant aspect | ☐ | ☐ | ☐ | ☐ | ☐ |
| Your work causes air and sound pollution to the environment. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Your work causes water pollution to the environment | ☐ | ☐ | ☐ | ☐ | ☐ |
| Your work might contribute to a better control of environment | ☐ | ☐ | ☐ | ☐ | ☐ |
| Quality control in your work is related environmental pollution. | ☐ | ☐ | ☐ | ☐ | ☐ |

**Section 3: Your current working situation**

Please fill in to the given box according to your information.

1. What type of work have you done today?

   ______________________________________________________________________
   ______________________________________________________________________
   ______________________________________________________________________
   ______________________________________

2. Was there any working situation within this week that makes you feel tired? Please specify.

   ______________________________________________________________________
   ______________________________________________________________________
   ______________________________________________________________________
   ________________________________

3. You feel stress after the situation passed.

   ☐0% ☐10% ☐20% ☐30% ☐40% ☐50%

   ☐60% ☐70% ☐80% ☐90% ☐100%

4. According to your comment, will the situation occur again within this week?

   ☐ Yes ☐ No ☐ Do not know

5. Was there any error or false occurred this week? Please specify.

   ______________________________________________________________________
   ______________________

6. Was the error or false been solved by the system properly?

   ☐ Yes ☐ No ☐ Do not know

## APPENDIX E: Abbreviations

**Abbreviations Used in this document**

| | |
|---|---|
| ABB | Asea Brown Bovery |
| AC 800M | ABB AC 800M controller |
| AE | Alarms & Events |
| AO | Asset Optimization |
| API | Application Programming Interface |
| AIS | Automatic Identification System |
| AO | Asset Optimization |
| API | Application Programmer Interface |
| APRS | Automatic Personnel Registration System |
| ASP x | Aspect Server x=(A,B,C) A=Primary B=Secondary C=Tertiary |
| ATEX | ATmospheres Explosives |
| CAP | Critical Action Panel |
| CAPEX | CAPital EXpenses |
| CCR | Central Control Room |
| CCTC | Closed-Circuit Telecommunication |
| CCTV | Closed-Circuit Television |
| CER | Central Equipment Room |
| CIF | Communication Interface Format |
| Client | Can mean either a physical client computer or a client process running on a computer |
| Control system | Used about subsystems that performs control actions on the Plant |
| C&E | Cause and Effect diagram |
| CMS | Condition Monitoring System |
| CMT | Control Module Type |
| cpmPlus | ABB Collaborative Production Management PLUS |
| RDC x | Data Collector x=A,B (A=Primary, B=Secondary) |
| KM x | Knowledge Manager x=( KM number) |
| CPR | Computer Printer Room |
| Device | Purpose made data communication equipment |
| DA | Data Access |
| DC | Data Collector |
| DCS | Distributed Control System |
| Dcy | DomainController:<br>y= A (Primary)<br>y=B (Secondary) |
| DCOM | Distributed Component Object Model |
| DHCP | Dynamic Host Configuration Protocol |
| DNS | Domain Name System |
| DSC | Digital Selective Calling |
| EIT | Electro, Instrument, and Telecom |
| EMS | Emergency Management System |
| ENGx | Engineering Client x=(Eng number) |

| | |
|---|---|
| ESD | Emergency Shutdown |
| External Firewall | The firewall connecting the Plant Network to the Office Network |
| ERP | Enterprise Resource Planning |
| F&G | Fire & Gas |
| FAT | Factory Acceptance Test |
| FDS | Functional Design Specification |
| FEED | Front End Engineering Design |
| FMC | Fundamental Modeling Concepts |
| FTP | File Transfer Protocol |
| GDS | Reuse Group Display Status |
| GMDSS | Global Maritime Distress Safety System |
| GUI | Graphical User Interface |
| HAZOP | Hazard and Operability Analysis |
| HMI | Human Machine Interface |
| Host | A computer connected to a network |
| HSE | Health, Safety and Environmental |
| HVAC | Heating, Ventilation and Air Condition |
| IAT | Internal Acceptance Test |
| IC | Initial Conditions |
| ICSS | Integrated Control and Safety System |
| ICT | Information and Communication Technology |
| IEC | International Electro technical Commission |
| IM(S) | Information Management (System) |
| INM | Integrated Noise Model |
| I/O | Input/Output |
| IO | Integrated Operations |
| Internal Firewall | A firewall connecting a subsystem to the Plant Network. |
| ISO | International Standardization Organization |
| ITS | Information Technology Services |
| JDBC | Java Database Connectivity |
| LAN | Local Area Network |
| LCD | Liquid Crystal Display |
| LER | Local Equipment Room |
| LL | Action alarm Low |
| LSD Controller | Large Screen Display Controller |
| MB 300 | MasterBus 300 control network, Advant Master Control Network Architecture |
| MI | Multisystem Integration |
| MMS | Manufacturing Message Specification (ISO 9506) |
| MS | Microsoft |
| NAT | Network Address Translation |
| NCS | Norwegian Continental Shelf |
| Node | A device or computer connected to a network |
| NORSOK | Standards developed by the Norwegian petroleum industry |
| NPD | Norwegian Petroleum Directorate |
| OCC | Onshore Control Center |
| OCx | Operator Client x=Client number |
| ODBC | Open Database Connectivity |

| | |
|---|---|
| ODM | OPC Data Manager |
| OOC | Onshore Operation Center (Onshore CR or Onshore Support Center) |
| OPC | OLE for Process Control, standard for process communication |
| OPEX | Operational Expenses |
| OS | Operator Station |
| OTS | Operator Training Simulator |
| OWP | Operator Work Place |
| PA | Public Announcement |
| P&ID | Piping & Instrument Diagram |
| PCDA | Process Control & Data Acquisition |
| PCS | Process Control System |
| PCSS | Process Control Simulation System |
| PDU | Power Distribution Unit |
| PID | Proportional-integral-derivative |
| PM | Project Management |
| PPA | Process Portal A |
| PSD | Process Shutdown |
| RACON | RAdar beaCON |
| RAS | Remote Access Server |
| RDBMS | Relational Database Management System |
| RDC | Remote Data Collector |
| RNRP | Redundant Network Routing Protocol. Supplementary protocol to TCP/IP used for establishing redundant networks where one is master network and the other secondary network. |
| RTA | Real Time Accelerator |
| RTM | Real Time Monitor |
| RSx | Remote Server x=1,2 |
| SAM x | Session Allocation Manager x=(A,B) (A=Primary, B=Secondary) |
| SAP | Systems, Applications and Products in Data Processing |
| SAR | Search And Rescue |
| SAS | 1. Safety and Automation System<br>2. Referring Hard drives Serial Attached SCSI |
| SAT | Site Acceptance Test |
| SCD | System Control Diagram |
| Server | Can mean either a physical server computer or a server process running on a computer |
| SIL | Safety Integration Level |
| SQL | Structured Query Language |
| SNMP | Simple Network Management Protocol |
| SNTP | Simple Network Time Protocol |
| SSD | Safety Shutdown |
| Symantec BE | Symantec Backup Exec System Recovery |
| Tb | Terabyte |
| TCx | Thin Client x=(Thin client number) |
| TCP/IP | Transmission Control Protocol / Internet Protocol, the most common set of protocols for office networks and internet. |
| TER | Telecom Equipment Room |
| Telnet | Ït is a network protocol used on the Internet or local area networks to provide |

| | |
|---|---|
| | a bidirectional interactive text-oriented communications facility. |
| | |
| Thin Client | Computer which depends on some other computer (its server) to fulfill its computational roles |
| UHF | Ultra High Frequency |
| UPS | Uninterrupted Power Supply |
| USB | Universal Serial Bus |
| UNIX | Computer Operative System |
| VDU | Visual Display Unit |
| VHF | Very High Frequency |
| VLAN | Virtual LAN |
| VmWare | Virtualization Software for desktops |
| VPN | Virtual Private Network |
| WSUS | Windows Server Update Services |
| 10BASE | 10 Mbits standard Ethernet connection |
| 100BASE | 100 Mbits standard Ethernet connection |
| Xooy | X out of y (for ex: 1oo3 means 1 out of 3) |