ŠKODA AUTO VYSOKÁ ŠKOLA, O.P.S.

Study programme: B6208 Economics and Management

Field of study: 6208R087 Business Administration and Sales

BUSINESS OPPORTUNITIES OF SIMULATORS FOR SUBSEA OPERATIONS

Jan DVOŘÁK

Thesis Supervisor: doc.Ing.Jana Přikrylová, PhD.

Replace this page with the assignment of the Thesis

I hereby declare that I have done this Bachelor Thesis myself using the cited literature and under the guidance of the Thesis Supervisor.

I hereby declare that the citation of used sources is complete and that in my Thesis I have not infringed any copyrights (in accordance with Act No. 121/2000 Coll., on Copyright and rights related to copyright).

In Mladá Boleslav on 15th May 2015.....

I would like to Thank to my project leader Jon Ivar Håvold, who was for me a great tutor during the research in Norway, he was a support for me and he helped me a lot with everything. Then I would like to Thank to people from Offshore Simulator Centre, Joel A Mills and Arne Styve who helped me with putting this research to a frame and get some basic knowledge which was needed for completing this task. I would like to say Thank you to my thesis leader in the Czech Republic, who is doc.Ing.Jana Přikrylová, PhD. Her help was very appreciated during putting ideas on a paper and last but not least important Thank you belongs to my respondents, that they found a time in their busy schedule, answered my questions and gave me the opportunity to see “into the pot” of subsea, offshore and oil drilling.

Contents

List of used symbols and abbreviations

AAUC	Aalesund University College
AH	Anchor handling
BOP	Blowout preventer
BP	British Petroleum
CEO	Chief Executive Officer
DP	Dynamic Positioning
FPSO	Floating production storage and offloading units
NMK	Norwegian Maritime Competence Centre
OSC	Offshore Simulator Centre
PSV	Platform supply vessel
PLC	Public Limited Company
ROV	Remote operated vehicel
USA	The United States of America
USD	The United States of America Dollar

Introduction

Today, the products from the crude oil are every day around us and our consumption of oil is increasing, and had increased in recent years a lot, more and more oil has to be produced than it has to be produced in past. Every day, millions of barrels of crude oil are produced worldwide. Tasks are more advanced as same as dangerous and more skilled and educated people are needed. It means that it is more difficult especially for a psychic of the working people in this industry. Companies should make for them these tasks as easy as possible and not put them into stressed situations, because they are still just humans and no robots. In the stressed situations humans tend to make a mistake which in this industry can mean a big catastrophe. One way how to avoid and prepare people for these stressed situations is simulation of operations on offshore simulators. Simulators are important part of offshore today and in future it could help to avoid, or at least minimize damage if something occurs like for example the problem in Gulf of Mexico in 2010 by British Petroleum.

I have chosen this topic, because two years ago in 2013 I was an Erasmus student at our partner's university Aalesund university college (AAUC), Norway. During one subject had I the opportunity to work with one of the most developed company in a world in the offshore simulation industry, Offshore Simulator Centre (OSC). They would like to build up a simulator which could be possible to use for subsea operations. Importance of this topic shows as well the fact, that there are already some market analysis which cost 3000$.

The thesis is divided into theoretical and practical part. In the theoretical part, methods of gathering data will be explained as well as the theory connected with the crude oil gathering, which is important for understanding the topic of this thesis. In the practical part, the subsea industry itself will be introduced and afterwards answers of the respondents and the business opportunities for subsea simulator will be presented. The thesis analyses the future and possible development in subsea operations.It will give a summary how a future in a subsea operations will look like and where are its business opportunities for company providing simulators and trainings on simulators.

1 Theory

Marketing Research

“Is the systematic and objective identification, collection, analysis, dissemination, and use of information for the purpose of improving decision making related to the identification and solution of problems and opportunities in marketing.” (Malhotra, 2010, p. 39).

Marketing research process consists of 7 steps:

1. Identification of problems and opportunities- It is very important to name problem right, so it can easily aimed to researching this. By identification of a problem researcher can get answers for questions about market, about the competitors, about the plans, previous marketing activities and the success.
2. Formulation of research needs/ research brief- In this phase is important to consult it with all involved departments. It should be discussed with them all the possible consequences which can occur from research. By this step, it is avoided to later complaints about changes:
    a. Basic assumptions why the marketing research is conducted
    b. Setting boundaries for the problem
    c. Background information
    d. Timescale
    e. Budget
    f. Characteristics of information
3. Selection of research provider/agency- The process of marketing research is time consuming activity. It has to be considered if there is a capacity in a company to run the research by themselves or whether it is better to rent a researching agency
4. Creation of research design/choice of research method- There are three main categories where research can be undertaken:

a. Exploratory Research- Is made to gain initial ideas and background about direction of our further research

b. Conclusive- Descriptive Research- describes what is going on. Answers question what, where, who, how and when.

c. Conclusive- Causal Research- Tries to explain whether there is some correlation among two variables. If one influences the other.

5. Collection of secondary data- Secondary data is data which were already collected for purpose of other research. It can be collected by our company earlier (internal data), or it can be from outside (external data)
6. Collection of primary data- Primary data is data directly connected with our problem, our research. One of the following method can be used: observation, qualitative and quantitative.
7. Analysis of data- Once, all the necessary data are collected, they have to be analysed. There is a difference between analysing quantitative or qualitative data.

Preparation and presentation of research findings and recommendations - Some researchers say, that good presentation and interpreting data is even more important than the research alone. (Berg, 2007)

Observation

Observation is data-gathering approach, where information about behaviour of people, objects, animals and organizations is gathered by observations. Researcher is a witness of a situation and he is just watching it, without any further questions. Either human observers orsome technical equipment can be used. . Observation can be also divided as qualitative and quantitative; it depends about the size of observed sample. Observations are made just publicly, if it is an observation of a private behaviour it is already behind the scope of observation. There are many different kinds of observations, it depends which tools are used, if the observation is visible or hidden and so on. (Kvale, 1996)

Quantitative

Quantitative research can be defined as research which is undertaken using a structured research approach with a sample of the population to produce quantifiable insights into behaviour, motivations and attitudes. Quantitative data are quantifiable because they are using larger sample of population. There are many different forms of quantitative research, telephone, personal survey, email and web. Quantitative research is based on surveys with questionnaires. Different kind of surveys can be used in this method. It also depends, if respondent fulfils the questionnaire alone, or he is just asked and interviewer fills it by himself.

Self-administered surveys are modern way of gathering data. It is used basically on internet. There is no interviewer, no data are recorded. As there is no interviewer who can help with questions or convince the respondent to answer, the survey and questionnaire has to be very clear, so the respondent does not need any further assistance. Also it has to be done properly to motivate respondents to answer all of the questions. Efficiency of this method is about 40-50%. It means that from 1000 sent questionaries, about 400- 500 come back. But with some surveys, the ratio is about 20%. (Kvale, 1996)

Qualitative

Qualitative research method is used when a deeper information about a topic is needed. . The sample is not as big as it used to be in quantitative method, but more time with each person is spent during the research. Results what is gained a qualitative research should not be used as a sample of all population they are not quantifiable. The respondents are chosen very carefully, as not everyone is appropriate candidate. Results from qualitative show us attitudes and behaviour, on the other side quantitative research shows us how widespread these attitudes and behaviour are. Many researchers use both of them together, because with the combination of both, you can get reliable data which can reflect well the society.

Focus group

Focus group is effective in a case that more people are interviewed at the same time, with lower costs. It permits the gathering of a large amount of information from potentially large groups of people in relatively short periods of time. Focus groups

do not require difficult sampling strategies. The quality of data is influenced by abilities of the moderator to conduct this group.

Depth Interview

This method is the second used in qualitative research. The difference between the focus group and interview is that interview is just between two persons. One interviewer, who also moderates the interview, and one respondent. Interview is a very effective method to gain some certain type of information and also to get the assumptions. In this case the researcher also has to be able to conduct it, but it is not difficult as it is in focus group. Quality of results is influenced by the relationship which is between them two. If the atmosphere is good, respondent will be more open on the other side if the relationship is cold, answers are not satisfying. The interviewer should professional enough to go over these problems with respondent and try to make it calm again and continue in normal way. (Shank, 2002)

Telephone Interview

It is a possible way how to conduct an interview, because the data can be obtained from a wider area with minimal cost. Due to the phone a sample of population that is in geographically diverse locations can be interviewed. The biggest disadvantage of phone call interview is that it is not face-to-face, so there is a lower chance of influencing the quality of data. Also it is harder to improve the relationship between two persons. If the researcher wants to influence the relationship at least little bit, it is recommended to contact the respondent firstly via a letter or an email for establishing the phone interview and wait for an answer. Interview should be held in a silent room, because it is difficult sometimes to understand the other side when calling. If it is quite difficult topic, it is also useful to prepare possible questions and send it to respondent.

“There are several important, necessary steps to accomplish a qualitative telephone interview. First, the investigator must establish legitimacy; next, the researcher must convince the potential subject that it is important for the subject to take part in the research; and finally, the researcher must carefully ensure that the information he

or she obtains is sufficiently detailed to contributemeaningfully to the study." (Berg, 2007, pp. 108,109)

Face-to-face Interview

This is the normal way of interviewing, the most used. Here the moderator can influence the way, how the interview is going. He can influence the relationship and he can also recognize if this question is suitable for respondent or not. Difference with a telephone and face-to-face is that here only people from our location can be interviewed, otherwise it is costly. Using of a phone is a cheaper way. For some people it is easier to have a personnel communication as the face-to-face interview is instead of non-personnel as for example the phone interview.

Interview Guide

Interview guide is basic part of every qualitative research. It gives theopportunity to prepare the interview, make some basic steps which should be followed moreover it is the guideline for the interviewer, as well as for the respondent. If a more difficult topic is discussedmore difficult topics, subsea for example, it is better to send the interview guide in advance, so the respondent is not surprised by the questions. Well prepared interview guide is very important for good conducting of interview. For an interview guide which was used during this research, see Appendix1.

For the purpose of this thesis observation and interviews were used.

Offshore Simulator Centre

Offshore Simulator Centre was established in 2004 as a reaction on a market need for highly educated and properly trained people able to manage difficult maritime operations. Although it is a quite small company, it is a world leader in offshore simulation. They built the biggest offshore simulator in the world and they have built simulators in France, Singapore, Australia and Norway.

Headquarters of company is in Ålesund, Norway. It is very important location, because the region is one of the biggest, most successful and important maritime clusters of the world.

Company is owned by *Rolls Royce Marine AS, Farstad Shipping ASA, Aalesund University College, Norwegian Marin Technology Research Institute*. Especially the cooperation with Aalesund University College is of a great importance, OSC provides hardware and software and AAUC provides the teachers and lectors. For OSC it means that they can reduce people, additional costs and for university it gives a possibility how to gain more prestige. Cooperation with Rolls Royce is valuable too because both companies are the market leaders in their sectors. And together they are even stronger. Rolls Royce equipment is used for the simulators, the same one is used on the real ships. Together with this and the fact that is used Hi-Tech technology, including 3D projection makes the simulation very realistic. (OSC- world most advanced offshore simulations)

Now OSC has bridge, deck, crane and engine-room simulators. All simulators are connected together so people on bridge can see the deck crew moving. Simulators can be also connected together all over the world. Due to the modern technologies they can run courses for example in Australia. The simulation is very realistic. Mariners know very fast how to control and operate simulators.

There are some competitors in simulators market, but their solution is not as good as it is from OSC, the differences can be find in the advanced software and hardware. Competitors provide cheaper solutions and lower quality, but provided quality is very important in this sector. That is the reason why companies many times go rather for the more expensive, but better solution. Screen technology used in its biggest simulator - bridge and deck - is used just in few companies on the Earth. Not any of them is such a small like OSC is. OSC is a market leader in this sector, which is made by the connection with Rolls Royce and also Aalesund University College. Because it can use the state of the art equipment from Rolls Royce, which is used in more than 90% of ship building industry. The connection with AAUC is important in the fact that the University provides qualified lectors for the courses, so OSC can reduce labour cost by employing just engineers, mechanics and

programmers. The importance of OSC is showed in the building of Norwegian Maritime Competence Centre (Norsk Maritim Kompetansesenter AS) where their bridge simulator is dominant of the building, because of its shape - huge half-ball. This symbol is used as well as a logo of NMK. For the pictures of simulators see appendixes 2,3,4.

Current Trainings

During the research, there was a unique possibility to watch *Team Performance Training* of platform supply vessel (PSV) crew. This training is two days long and it is divided into two parts - theoretical and practical part. The purpose of this training is to make a ship crew better team and moreover let give them possibility to try things, which are normally done by someone else. First day the theory part takes place and it emphasizes especially awareness of a situation, risk assessment and improving leadership and collaboration skills. Theory is connected with different examples from real life. After this part there is possibility to try simulators. This is all just that crew can try control or do things, which they are not doing normally because of their qualification for example. It is important for crew morality, if they see that the other tasks are also very difficult and demanding. Because it is common problem of a crew, when someone thinks that his task is the most difficult and the others are just lazy and doing nothing when it necessary.

Second day is practical training. There are different case studies, everyone from a crew is on his own position. Half of the team is practicing and second half is watching them on the screen in a classroom. Cases are conducted by a teacher. Practice is then evaluated by him and also the part of crew which is watching. After the practice, they all sit together and everyone says what was wrong, what could be better. These cases are run with different configuration of weather and also different positions of ships and platforms. During the discussion with a crew it was mentioned that, for them was interesting to try different tasks and then also the cases, because it is different with weather and that is good to just change weather in computer and do not risk safety of a crew.

OSC can currently provide a bridge, crane, deck and engine-room crew training, they would like to develop simulator for subsea operations as well.

Process

The main purpose of this research is that OSC wants to establish a subsea simulator. According to them the market now is more and more concentrated about subsea and they see it like a potential for developing their business. The research was done by interviewing people from the companies operating in the subsea operations and was aimed to gaining information about the possible market for the subsea simulator.

Contacts for the respondents were gained from Joel A Mills, CEO of OSC, for the companies they worked together with. Also my teachers at AAUC had some contacts from their previous time. I contacted the respondents thru an email, where I also sent them the interview guide and the time for phone interview was discussed as well. .

Interviews

Interviews were held thru the telephone, because the respondents were from different locations. Respondents were specialist in this kind of industry, but as topic is difficult, it was better to send them an interview guide in advance. All interviews were recorded with tablet Samsung Galaxy Note 10.1 and program Smart Voice Recorder. Interviews took about 35 minutes and during that time all neccessary information were obtained. The answers of the respondents were very similar so it gives a good picture about the future in the subsea operations. Due to these interviews from respondents within two different companies, recommendations how to build up and improve simulators for subsea can be done. The research is based on interview with 4 respondents, 3 by phone and 1 by email. These were *Jon Slinde and Arold Ramstad from Statoil, Staale Kalsnes and Jeff Knight from Farstad*. The communication with Jeff Knight had to be held thru email because he is working in a Farstad subsidiary in Australia and we were not able to find a suitable time for a phone call.

2 Crude oil gathering

The current situation in the oil production demands new and better ways of processes. The tasks are more difficult and advanced as well as the demand of crude oil and natural gas is increasing worldwide. Many of the current onshore (on the ground) oil and gas fields are being exhausted as they are in usage for years already. That is why new resources and reserves (difference between resource and reserve is that firstly, if something found it is resource, once when checked, confirmed, accurately measured and counted its value it becomes a reserve. Reserve has to be economically recoverable according to actual prices) are wanted and searched. Also the way, how to get out of the current fields as much as possible, prolong their life or optimize them is now the key point for the engineers.

In the year 1896 situation in oil production changed and it opened new way of getting natural sources, when Henry L. Williams produced first offshore (out of the ground, on the water) platform and started to get oil from the sea. At that time, it was just about ten meters in depth and his platform was connected with the shore by 100 meters pier which he created for this purpose. It did not take a long time and the others started to follow him and more and more piers ended with an oil platform were located in the sea. During almost 120 years of drilling offshore it developed to a very advanced industry and very good business, where a lot of money is used, but even more money is gained. Today, most oil and gas extraction still takes place onshore. Nonetheless, a considerable amount of gas and oil is already produced offshore. Offshore oil extraction currently accounts for 40 per cent of global production. At present, 30 per cent of global gas production takes place offshore – and this is increasing. Today there is about 900 large-scale fields of oil or gas worldwide with maximum deep about 3000 meters under the sea level. New resources are still being searched and are found. For a mapping of the sea bottom are used the art of the state equipments and technologies. (World Ocean Review, 2015)

Oil production

Once a resource is found, checked, measured and valued it transforms to reserve, as mentioned already. Those reserves are ready to be extracted. For many years,

offshore natural gas and oil production was restricted to shallow waters e.g. North Sea or the coast of a Gulf of Mexico. Because of many older fields became exhausted, companies have increasingly moved into deeper waters. Three separate depth categories are defined: (World Ocean Review, Oil and gas from the sea, 2014)

Drilling

First of all well need to be drilled. For this the drilling facilities and equipment are used. In the beginning of drilling is installed on the sea the *Blowout preventer* (BOP), what is tower like steel car-sized construction sitting on the future production hole and is equipped by several safety and security systems to prevent a blowout of an oil when the drilling is done. The drilling hole is drilled by drill bits with grinding elements, powered by its own small engine just behind the bit. The drilled hole is secured by a steel pipeline, 10 meters long pieces screwed together. The drill bit is connected by a drilling string with a drilling platform. Today the direction of the bit can be changed already during the drilling, earlier it was possible to drill one direction only. Also the technology todays enables to branch drills, so it can be rooted like a tree to maximize the output of the reservoir. When the drilling is done, drilling bit is pull out as well as the drilling fluid, which contains the rest of drilled rock and so it is very heavy and create pressure against the well's wall and against the oil and gas. This fluid is replaced by sea water, which is of lower density than the drilling fluid. The pressure of sea water is not enough to keep the oil and gas in its reservoir, that is why special cement plug is installed far down in the rock to seal the well and keep it until the production platform is properly installed and connected. During the installation of the sealant the pressure is checked by specialist and reported if there is any problem Drilling platform is moved to another place. For the drilling process external service companies are contracted.

Oil extraction

When the production facility is properly connected, production of oil or gas can start. There is almost no difference in the technique of extracting oil or gas. The extraction process, however, is different for the two resources because oil is viscous and only flows to the well naturally for a limited time as long as the reservoir pressure is high

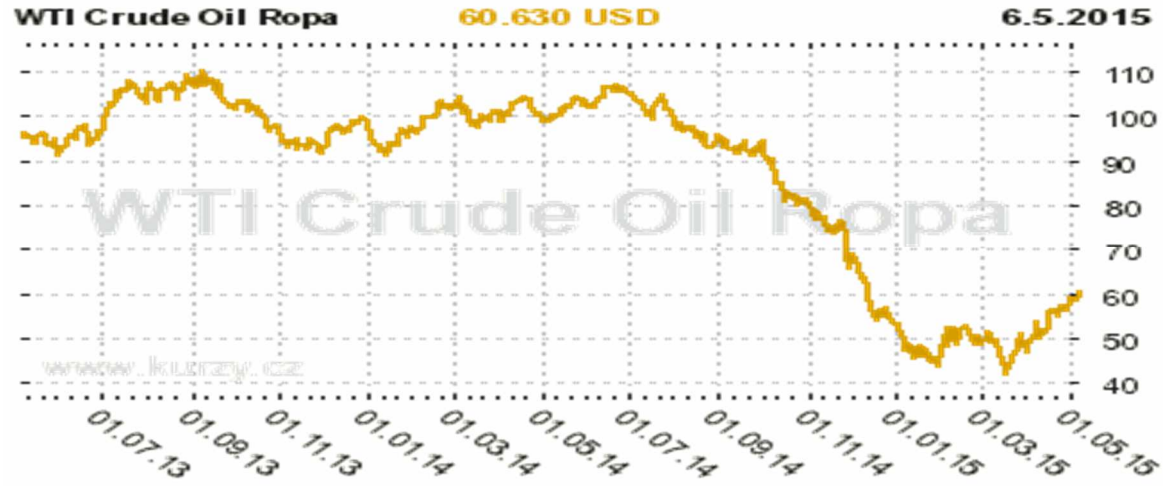
enough. The flow dries up as the reservoir empties and pressure drops. The reservoir pressure must then be artificially increased by technological methods.

The artificial increasing of the pressure in the well is called *Fracking.* This new method highers the efficiency of oil fields up to 60%. This new method connected with subsea operations allows re-opening of an old, closed fields. Subsea is used for lowering costs and making the fields more profitable. Oil is filtred directly in the water and only oil is sent to thru the pipes to the platform. Also, using subsea facilities directly on the sea bottom increase the pressure in the well.

Oil price

Price of oil was increasing during last decades which enabled usage of more advanced technologies to product even more oil. Even with the higher research and development costs, and more expensive technologies as e.g. Fracking, wells had been still profitable.

In 2014 the price of oil decreased dramatically. In June 2014 the prices reached its maximum at 115$ per barrel of crude oil, during half a year the price dropped down to 55$ per barrel in January 2015. Which was also partly initiated by an advanced fracking methods what was developed in the USA. This means that USA could become an independent country in oil import in few years.



Source: http://www.kurzy.cz

Figure 1 The price of crude oil per barrel in USD in two years horizont

This price dropdown caused a lot of problems on some markets, as they were calculating with double price per barrel. Some oil production dependent countries' governments need to have certain price of oil to fulfil its budget. Especially offshore production became at some fields ineffective and the onshore fields and production were pushed forward, because generally onshore production is cheaper than offshore production. This helps companies to be still profitable, but on the other hands, it makes even faster depletion of current onshore fields. Together with increasing demand of oil it means that companies will have to go back offshore and start again the production process of expensive oil. This will again higher the price of oil.

Oil platforms

The main differences within the platforms are if it is a drilling or production platform and if it is fixed platform or floating. For our purpose is not that important whether it is a drilling or production platform, our point of view are platforms itself.

Fixed platforms differ if it is supposed to be on just one place, or if it should move to another field, when one is exhausted. Due to this is also its construction fitted for its purposes. The biggest fixed non-moving platform is the *Bullwinkle* oil platform, which was erected in 1988 in the Gulf of Mexico as a production platform. It is a full 529 meters tall. The water depth at its deployment location is 412 meters. The steel construction was fabricated on land and then towed out to sea. For imagination, the Eiffel Tower in Paris, France is just about 324 meters tall. (World Ocean Review, 2015)

Fixed moving platforms are those platforms which are installed at the field, but they can be uninstalled and towed to other place, i.e. Jack-up drilling rigs - those platforms have own legs, which are lowered and seated on the sea bottom. They can be easily pulled out again. This kind of platforms is very often used for drilling in shallow waters up to 150 meters.

Floating platforms are non-fixed to the ground and can be very easily moved to other place where needed. It can be two kinds of them, one is normal platform - called *semi-submersible platforms*, which are equipped with own engines to move moreover it is because of using dynamical positioning (DP) what ensures the

platform on one place in the sea even during big storms. Those, because of its structure, are very often used for drilling. The second kind of floating platforms is called *Floating production storage and offloading units* (FPSO). FPSOs are ship looking platforms which can be used for production, storing and offloading oil or gas. They are secured with dynamic positioning system as well as some small anchors. Because of its flexibility, they are often used for smaller oil or gas fields, where the installing of a fixed platform would be economically unacceptable.

Subsea operations are used in connection with all kinds of platforms as they help with installation of the platforms. Then platforms are controlled and checked with the use of subsea.

Environmental damage, safety and security

Safety and security is very important topic offshore. Some of the errors and mistakes which lead to the environmental damages were caused by not handling of the safety regulations, or inappropriate education of the crew. Today it is known that possibility of making this mistakes again can be lowered by proper training on simulators

Deepwater horizon

Deepwater Horizon was *British Petroleum* (BP) mobile drilling platform which signed in the history of oil's industry as the biggest accidental oil spill. Because of the explosion on 20th April 2010, 11 workers lost their life and 16 other got seriously injured, around 700 000 tons of crude oil released to the Gulf of Mexico.

The accident happened during the last step of drilling. When external company was done, they started to fulfill the hole with a seawater, meanwhile the cement sealant was installed by another external company and the pressure was checked by its engineers. Even thou that some problems with pressure occurred, showing that the sealant is not appropriate, they did not report it as a problem, as they misinterpreted the pressure test results, assuming that there were distortions in the readings. Once a sealant did not stand the pressure of an oil and gas and failed. Gas went then thru the drill and pipeline and accumulated on the platform, where it was initiated probably by a spark from engine room. After the explosion the drill hole went totally

out of control, and even the BOP was damaged in the way that it was not possible to stop the releasing oil. (Cleveland, 2010)

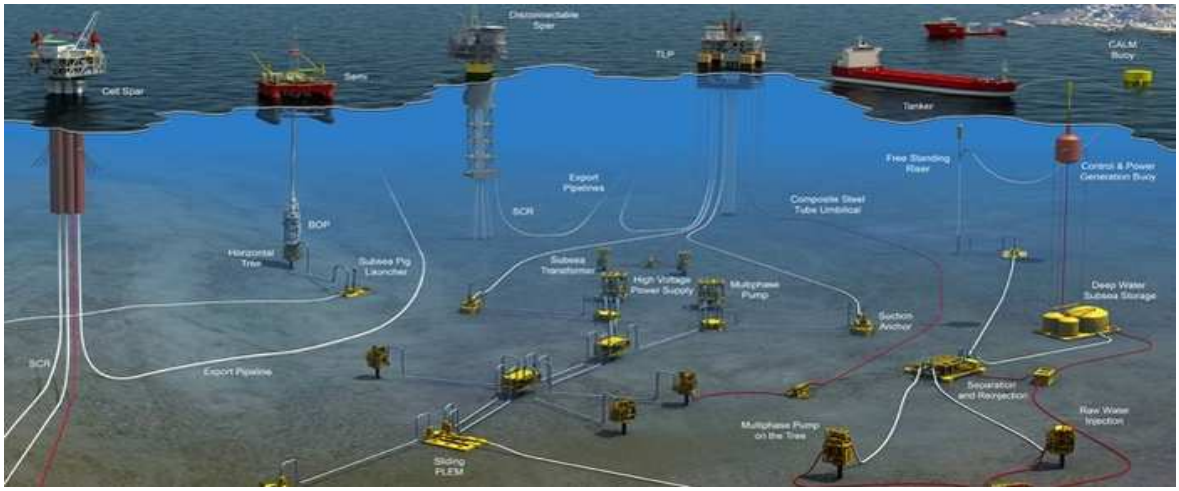
It took three months until engineers managed to build and install appropriate capping stack - tall steel construction on the BOP retaining the released oil inside it and pipelines to the platform were installed. Damages on the marine environment are huge and it will take up to 30 years until the nature recovers from it. According to economists, the blowout at *Deepwater Horizon* has cost the company around 42 billion US dollars. (World Ocean Review, 2015)

As a result of this, new safety and security regulations were accepted and put to usage. Today every platform has to have one fully responsible person who has to be reported by everything what is happening on the board. Also new cooperation were made securing combined trainings between countries and preparing them for an oil spill situation. Moreover security companies were established sitting on places all over the World having at time several capping stack on board, so in a case of emergency they can be transported within hours to the place where needed. (Offshore Magazine, 2013)

If there would be a simulator and crews would be properly trained on simulators, using the courses with intense in communication and cooperation it could forego the accident. Furthermore rescuing ingeneers could try out the installation of BOP and the process could be faster. The overall damage could be much lower, because of simulator and courses connected with them.

3 Subsea

Today, gas and oil production operations are no longer limited to using large platforms on the sea surface. With an increasing number of offshore platforms and increasing price it is not surprisingly that a new direction was developed to satisfy all the new upcoming needs - Subsea. Subsea means everything which is happening under the sea level, basically everything happening in the water and not on the water. Subsea operations are proceed by special tools and equipment as it is not possible for a human to survive in such a depths. Those tools are called *Remote operated vehicles* (ROV) and are operated remotely from the platform or vessel. Operating it requires a special training for its conductor. ROVs are equipped with different tools according to its task. This kind of operations which are today made are environmentally dangerous and with bad weather some operations cannot be proceed. Because of previous accidents with platforms and their wells, there is a demand for higher safety of these kind of operations and moreover qualification of the people. Current situation is not bad, but there is a lack of high educated and trained people in subsea. The environmentally damages are because of higher than it could be if appropriate training would be provided. The current situation in the oil production is demanding new and better ways of processes. The tasks are more difficult and advanced as well as the demand of crude oil and natural gas is increasing worldwide. (Offshore Magazine, 2013)



Source: http://www.internationalsubseaconsultantsllc.com/about

Figure 2 Different subsea facilities and tie-backs

Platforms inspections

Subsea was firstly developed for checking and inspecting parts of the etc platforms, anchors, pipes, wells and similar in the water. Within next five years all the current platforms should be checked and inspected, wrong parts replaced. This during the full work load of platforms or in case of replacing, the platform needs to be stopped for as less as possible, because of its profitability. Analysis of the anchored platforms has been done and the result was shocking. Up to 75 per cent of platform's anchors are positioned in a wrong way in their seats. Those anchors are huge steel constructions weighting tens of tons and biting in the sea bottom with its weight and shape.

New projects

Subsea operations are also used in new upcoming offshore projects, where they help with seating of fixed platforms or help during the anchoring operations. ROVs are used to check if the process was done correctly, or if there is any problem. With its tool it can also navigate e.g. anchor to seat in the right way. Building wells, underwater platforms and different pipelines also use different subsea operations. There is increasing trend of building one platform with many wells, so then the oil has to be transported in the water by pipeline, to the platform or to the facility onshore. Also there are more FPSO ships which need subsea operations too.

Subsea facilities

Thanks to the increasing depth of waters platforms are operating in, the idea of building subsea facilities directly at the sea bottom was developed. It has two main reasons. With an increasing depth of wells the pressure in pipelines is getting lower and it is more difficult to get the oil or gas up to the platforms and secondly the current platforms are weather sensitive, it means that they cannot be operated during bad weather. It is too dangerous for the people working there and it could lead to some life loses together with some environmental damages. Also platforms need to be served by some vessel and it is not possible in a bad weather as well.

It means that, with use subsea facilities, operations are not facing to those two problems as the weather is stable in those depths even if there is a storm up on the sea. And the pressure of oil is obviously better when it is closer to its source. As well

the oil can be assorted from sea water, sand and other dirt directly in the sea so the pure oil gets up to the platform. Subsea facilities can also be used for connecting some smaller field - called *subsea tieback*, where building up a platform would be inefficient. Instead of platform, subsea facility is used and the well is thru this connected to some other platform which is situated farther. The production facilities are the keypoint here, as for drilling there are still people needed and the process cannot be fully automatized.

Some of the subsea facilities have been already built and are producing oil. Subsea facilities are built up on the well head using BOPs and they can be connected to each other with pipelines. These include various water-tight components such as compressors, pumps and separators for gas and oil processing mounted on steel frames. The oil can be transported from different wells in one field to the one central subsea facility, which collects the oil and re-transport it to the platform or FPSO. This makes the process more efficient because one platform can operate more wells and not just one. Oil can be sent thru the pipelines directly onshore without no platform needed. On offshore platforms, compressors, pumps and compactors can easily be maintained, but with systems at great water depths, this is less straightforward. There, a defective machine would be a serious problem. (World Ocean Review, Oil and gas from the sea, 2014)

Building up a subsea facility is very expensive because of all the process are done in the water by ROVs operated remotely from ship or platform. Also development of the equipment is expensive because special materials are needed. Current tools and materials would not have stand the pressure in such a depth. On the other side, the running costs are lower as it is not influenced by weather and the production can go without any break. For example one day of operating a platform’s serving vessel can cost 5-10 million CZK. Even if the vessel has to stay in a harbour because of the weather, it costs money, as the crew has to wait and be ready in case of improvement of the weather.

Problems and Obstacles

Problems and obstacles in the future of subsea are mainly the difficulties of more and more advanced tasks, where any failure could mean a big environmental

problem with a huge impact on a reputation and nature. Another risk also connected with a failure is a financial risk. Financial risk is also connected with the problem of changing price of oil, now is the price low, but as already mentioned earlier, the price of oil is increasing again. All these together make the subsea operations very advanced and difficult, companies know that it can bring a lot of money or a lot of problems, so they are demanding highly skilled and trained people.

Competence, attitudes and skills of a crew

Due to the fact that this sector is growing very fast and is advanced there is a need of high educated, skilled and trained people who could do these tasks. The crew operating an ROV is made by a people with different background, some are electrical engineer, some hydro mechanical and so on. This is caused by the fact that every ROV has to be checked after the operation. Same competence as it is now with AH or PSV operations will be needed also in a future. There will be lack of these educated people because the trend of using subsea is faster than the appropriate training. This training can be gained at Universities, companies and some additional courses. People from school they are really good in the theoretical things, but in these operations the practical side is also very important. On the other side people with practical knowledge are not so strong in theory and it is useful to remind them sometimes. The right mix of theory and practice should be well balanced and it is task from task different.

Very important is situation awareness, which can be explained like: “Knowing what is going on around you.” A certain level of situation awareness is necessary to successfully function in most areas of life - not only at sea, but also for safely driving a car, for avoiding work-related accidents and even for safely walking around in a city centre.

Communication

Communication is in subsea, as same as in current AH or PSV operations, very important. Because of the ROV crew is mainly external is the communication between two or even more different crews a key to success. Appropriate communication connected with subsea is highly needed, otherwise there can be for example lose of contact with ROV. A lot of factors can influence how good the

operation is done, for example weather. In AH or PSV operations can the crew see the platform, crane or anchor, but in subsea they cannot see the ROV in the water. The bridge has to be in contact with the ROV operators and crane operators. Also the fact that crews are from different companies and they do not know each other makes it difficult. As the subsea trend is increasing and the locations go wider and wider in new areas, there could be also cultural problems in some crews. Especially with new areas around Africa this could be dangerous and the right knowledge of culture and cultural communication could make this problem little bit easier.

Safety and Security

Security offshore and safety of a crew and environment are very important, especially with accidents which happened in previous years. Security is influenced by a lot of factors, and the right training of a crew together with some courses about importance of communication and awareness of situation are helping to make the work on the sea safer. Every small part which can higher security and safety offshore is very positively welcomed and appreciated even if it sometimes look for people not working offshore strange.

Research and Development

R&D is important part also, not just the research in subsea, but also the research in simulation, because it necessary to follow last trends in industry to keep gained position. As the tools will be more advanced, simulators have to be advanced same. Otherwise it would lose the advantage that simulators are almost like a reality. Companies should not forget this important fact and keep their solutions competitive with other subjects on the market.

Pre-operational Training

Pre-operational training, which means to have a possibility to try out the task what have to be done, would be very appreciated because of the difficulty and danger of tasks. Now some companies, where it was needed, made the model of the pipeline, put it in the water and then they tried out with ROV to simulate the reparation of it. This solution is expensive and takes more time, so pre-operational training provided by simulators with possibility to try different weather configuration and different ways of communication with the ship crew is demanded from the market. According to the

respondents it would be really useful for crews operating together to try out before they go to the real on the sea. This makes them better cooperating unit on the sea.

Good thing on simulators is that you can easily change the configuration of everything and try it with different conditions, so then the crew is prepared for everything. On the sea it is already too late to think how this would work with this and this. It has to be done before.

Training Package

Training package as it is now is quite well built, there is a theory part, practical training and also there is a possibility try other positions, which is not possible during real time operations. For the future this training could be basically used just with some improvements. There should be a wider offer with different possibilities and options so companies could choose what they want to have in training for their crew. Now the training is built and it is done. For example in theoretical part, if crew is operating in some other areas, or with foreigners, there could be also part about different cultures and how to deal with them. As example the webpage of Geert Hofstede and his 5 cultural dimensions could be used. This will prevent some problems which could appear later. Also the part about communication could be made different. The theoretical part is little bit boring and during the observation people were losing attention quite fast. There are different “games” especially for showing how important communication is. It could make the course funnier and also more interesting for crew. It would be more useful for them than just a presentation. Also as every task is little bit different and the skills and knowledge of the crew are different, this should be considered in a planning of training and every course should be fitted exactly for demand of the company. This would increase the reputation of OSC and with higher and better reputation comes also higher market share and profit.

As it was mentioned before the discussed mix of theoretical and practical knowledge should be somewhere about 50% to 50%, but for some tasks more theoretical background is needed and vice versa. This should be discussed before every course with the customer. This will distinguish OSC from other companies which are providing just one general solution.

Also the possibility of a completely new course, which could requalify the current crew or new students to ROV crew and make them subsea ready could be an interesting idea because of growing demand about high educated people for subsea. There could be also new course at university, current maritime students are using the simulators and it would be the same in the case of ROV course.

During courses the importance of communication should be mentioned and also showed by putting some obstacles in communication that would be also simulate the real life because you never know when something will be broken, stop working and so on. If the crew will see how difficult it is without any communication, they will understand how important it is.

Simulator for Subsea

The more realistic would be simulator using real water. But it is not a performable thing. There would be big pool needed and it could not be such a free in different settings and alternatives.

Simulator using screen and projection is much more possible way how to make a simulator. There is not a clear picture how it should look like from the hardware side because even the respondents would not able to answer this. Something similar like a current crane simulators with a specific tools was mentioned during interviews. This is a question for engineers in OSC, also in the beginning of the cooperation with OSC was mentioned possible cooperation with a Canadian company who provides ROV simulators and this choice would be the best, because development of a new simulator takes more time and in this case time is very important. Both companies will use their best together to develop really advanced simulator for subsea operations.

Software should be as developed as it is now, but with some changes. There should be possibility of different water settings, like a visibility and plankton, as every water is different and it influences the quality of provided task. Also the possibility just easy change used tools on ROV and cooperation with crane simulator is demanded. The cooperation of all simulators together, bridge, deck, crane, ROV and engineering room is solution which is in a world of simulators unique and it gives great opportunity for OSC to become even stronger.

4 Subsea operations simulators opportunities

Subsea operations are the future trend in oil production because of increasing demand of oil and gas and current onshore as well as some offshore fields are getting exhausted. Importance of subsea is increasing as well as some subsea facilities are already in usage and the others are being planned and will be built up soon. There are already plansfor the subsea facilities of a football pitch size in a depth about 3000 meters. As it was mentioned during one interview, the subsea is the future, because of its potential.

All this, obviously, demands the people who will operate the ROVs used during subsea operations, as well people in charge of the subsea itself. Subsea demands well educated trustful people, because of the operations have to be done precisely and correctly. In all oil production industry there is not a place for any mistake; in subsea this is valid twice. The speed of the growth of a market in next 10 years is predicted to be faster than it was before 10 years till now. Subsea market is kind of young and not developed yet and companies can profit if they are able to offer something new, which is not on the market yet. Where can be this proper education and training gained and used? Let’s take a closer look at possible usage of subsea operations simulators.

Education

Gaining experiences during the studies is very important, especially when for certain tasks certified mariners are needed. Certificate mariner can become only someone with an education in a field and with some practice. Amount of practical knowledge needed goes higher with asked position. During studies it is economically unable to let students operate on real ships, not just it is very costly, it is even dangerous. That is why simulators are used in education field, subsea simulator will not be an exception. Those educational institutions are located all over the world, where there is a possibility of an offshore or onshore opportunities. Here is a list of field of studies where the simulators could be used during classes to gain appropriate needed experience.

Nautical studies

Probably the field of study, where the simulators are needed mostly as this field of study is for future mariners who wants to operate on a ship. The students will acquire the qualifications required to obtain managerial positions offshore and onshore within maritime activities, additional seagoing practice is important and is mandatory, if the student wants to gain a managerial position.

Education already now consists of using simulators for operating the ships, establishing subsea simulator would enable to widen the field of study with an subsea branch, it could stay next to fields which are already being taught (Hials-studies, 2014)

1. Deck crew – Crew who is working on the deck of ship. This is the most dangerous position on the boat, so very strict safety rules are obtained. People working here need to be in a good condition according to physical and psychical power.
2. Bridge crew - People working on the bridge of the boat and operating the vessel and all its operations by demands and orders. Very important are communication skills on those positions, leadership skills as well because the people in bridge are responsible for all the team on the vessel. Highest degree reached here is the Master, also somewhere knows as Captain. Followed by Chief Mate, second and third officer.
3. Crane crew - People operating cranes and different tools on the boat. They need really to know how to operate its tools. It is demanding during normal-sea operations, moreover on subsea operations in the deep water.
4. Engine crew - Engineers working there are responsible for movement of the ship, they are listening commands of chief engineer who is the part of the bridge.

Ship design

This field of study is not directly connected with subsea operations, but it is important for the students to see how their product can be operated and manipulated during the operations. It gives them the opportunity to make the product even better and

more tailored. During studies are different case studies and tasks, which could be proceed on a simulators and it will bring better results. There was an opportunity to talk to some ship design students who has the possibility to use simulators during the classes and they really appreciate this possibility.

Simulation and visualization

For this field of study is the cooperation with one of the best company in the world according to the maritime simulation very important. Students can use their experience and gained knowledge and put it to the real by establishing and adjusting simulators, moreover they can see the impact of the simulation during commercial trainings provided by company. They have an immediate feedback and are able to improve the simulation process.

Maritime education

There are different kind of marine high schools preparing the students for the life as a mariner. With this high school you can work in uncertified positions on the vessel, or you can continue to the nautical bachelor and get a certificate to gain certified positions on the ship as for example- captain, chief mate, watchkeeping officer and others. Simulation is important to get an overview of process and it can lead to some kind of specialization of students. As the tasks are getting more and more advanced, there is certain specialization needed to operate and work within subsea operations.

Companies

Of course, simulators are very important for different offshore companies as the proper training for all crews is needed. For the companies it is very good way how to get its crew well trained or educated. To require the high standard for safety and security certification. Companies who need a simulator can be different, from the companies who are building ships or equipment, across the companies producing oil to the companies selling subsea solutions, here let’s take a closer look for some examples of those.

Ship and equipment building companies

It is normal in this industry when some ship is ordered and built, there is also training provided on the same equipment as is used for the vessel itself. This is to prepare the crew operating on the vessel as best as possible.

Rolls Royce

The marine division of Rolls Royce is a current market leader, with about 90 per cent share of the market with an offshore equipment. Headquarter is located in the biggest marine cluster in Norway in Aalesund, where they cooperate with an Aalesund university college, providing together the lessons for nautical students. Rolls Royce is not building a ships, they are just supplying the technical high advanced parts, e.g. bridge equipment, cranes, engines and so on. Their equipment is used by all big shipbuilding companies around the World. Companies know that they can trust and rely on the Rolls Royce equipment. Rolls Royce equipment is used for current simulators as well, which makes sense as the training is more realistic and for the trained crews it is familiar. Rolls Royce Marine AS is now quarterly owner of the OSC, which makes the cooperation even stronger and the training easier. (Rolls Royce, 2014)

Farstad

Is representing the companies which are operating the vessels during offshore operations. They belong to the biggest six companies in the world in the large and middle platform supply vessels market. Th eir headquarter is as well in Aalesund, Norway, and they are running operation offices in Australia, Singapore or Brazil. Connection with a simulation company is obvious in the case, that the training is required for the crews operating on vessels to higher the safety and security on board and lower the possibility of an error, mistake and damages. Farstad is also one quarter owner of the OSC. Together they built up Farstad Simulation division, providing an offshore simulation training in the Australia (Farstad Simulations, 2013).

Havyard

Represents the classical ship building company, where the ships are made and tailored for needs of the customer. Meanwhile the ship is being built, the proper training for its crew has to be done as well. Simulators are good choice for this purpose (Havyard About us, 2013).

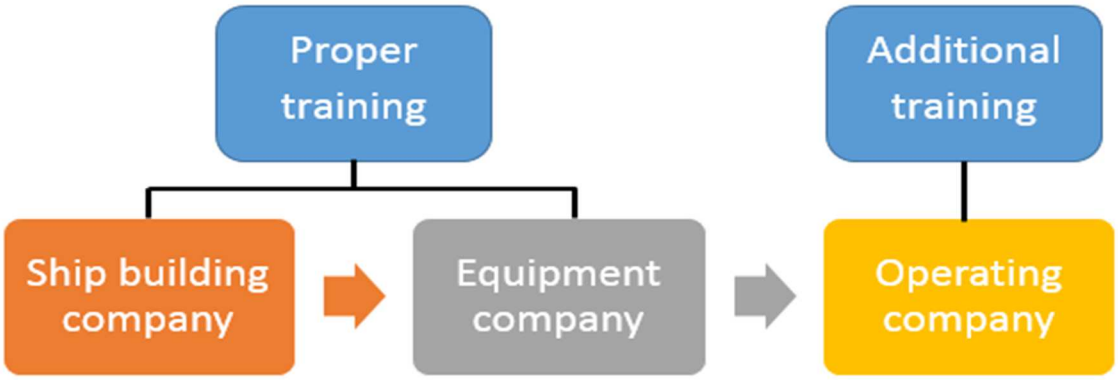


Figure 3 Smart chart showing the proces of ship building and the need of education

Subsea Operations company

Those companies are just providing some of the more difficult subsea operations and are responsible for subsea equipment and development. They have their own operating vessel or their equipment can be rent for operating on other vessel (Top companies in the subsea oil and gas production market, 2014).

Subsea 7

It is a company registered in Luxembourg with a headquarter in London, England. They run offices all over the World e.i. Australia, Brazil, Canada, Egypt, France, Ghana, Indonesia, Luxembourg, Malaysia, Mozambique, Nigeria, Norway, Portugal, Russia, Singapore, USA and United Kingdom (SUBSEA 7 Who we are, 2013).

FMC technologies

It is an American global provider of equipment and services for the energy industry. The company has approximately 19,700 employees and operates 30 production

facilities in 16 countries. FMC Technologies designs, manufactures and services systems and products such as subsea production and processing systems, surface wellhead systems, high pressure pumps and fluid control equipment, measurement solutions and marine loading systems for the oil and gas industry. The company also specializes in subsea technologies that maximize recovery of hydrocarbons from challenging reservoirs (FMC Technologies, 2014).

Cameron

It is the traditional company and one of the most advanced in producing floating and subsea equipment. In 1922, Jim Abercrombie and Harry Cameron designed the world's first blowout preventer. The new invention revolutionized the fledgling drilling industry and soon, Cameron's BOPs were being used throughout Texas and as far away as Mexico and Venezuela. In 1962, Cameron became the first company capable of designing and delivering a complete underwater drilling system. The company is in subsea represented by its own brand – OneSubsea (Cameron technology, About us, 2015).

Dril-Quip

Dril-Quip, Inc. designs, manufactures and sells drilling and production hardware and a wide variety of capital rig equipment for use by oil and gas companies. Dril-Quip's extensive product offering is well suited for use in deepwater, harsh environments and severe service applications. Dril-Quip also provides installation and reconditioning services, and maintains one of the largest fleet of rental running tools for use with its products in the industry. With locations worldwide, Dril-Quip is well situated to serve the growing oil and gas industry (Dril-Quip, Company profile, 2015).

Aker Solutions

Is a Norwegian oil services company headquartered in Oslo, Aker Solutions is a global provider of products, systems and services to the oil and gas industry. Its engineering, design and technology bring discoveries into production and maximize recovery. The company employs approximately 17,000 people in about 20

countries. The company, with roots back to 1841, was known as Aker Kværner prior to 2008 (Aker Solutions, Who we are and what we do, 2015).

Oil producing companies

Those companies are not operating the vessels, they are operating platforms, where they are producing oil or gas and for ship services mostly they are hiring external companies.

As they are the one who owns the wells, they are responsible for all its possible problems what can occur during the process too. It is their responsibility to check whether the crew has gone thru the right training process. They can provide trainings for special tasks which could be possibly dangerous. In the end, it is their money paid for the environmental damages and emergency situations. The world's biggest six companies in oil and gas production called *Big oil or Supermajors,* one Norwegian company, and the biggest oil company in the world will be introduced.

BP

Also known as its former name *British Petroleum* is a British oil and gas producing company, headquartered in London. BP is with worldwide field of range, operating in about 80 countries and employing almost 85000 people with the amount of reserves about 17,523 million barrels of oil equivalent. BP was the owner of *Deepwater Horizon* during its explosion in 2010. The overall costs for the company are estimated about 45 billion $. They had to sell some smaller fields or shares to be able cover all the refunds, fines and penalties which were asked by the courts. Except of the fact that it took months to repair the broken well and stop the oil spilling into the sea, which was not just a mistake of BP (several projects failed because of lack of training and right equipment as well) the situation was managed quite well. Their crisis management was very good, they admitted all the situation what happened and they offered a lot of money as refund for damages. This helped to recover the image of the company and BP was in 2012 the 5th biggest company in the world according to revenues. BP is a worldwide brand in gas station industry, in Europe complemented by the brand Aral (BP, at a glance, 2015).

ExxonMobil Corporation

It is an American multinational oil and gas corporation headquartered in Irving, Texas, United States. It is a direct descendant of John D. Rockefeller's Standard Oil Company and was formed on November 30, 1999, by the merger of *Exxon and Mobil*. It is affiliated as well with an *Imperial Oil* which operates in Canada. The history of company is also written by several oil spills, the biggest was *Exxon Valdez* oil spin. It was an Exxon's tanker ship which crashed in March 1989. The amount released to the sea was much lower than during *Deepwater Horizon* but the damage for the environment was worse because of the locality, Prince William Sound, oiling 2,100 km of the remote Alaskan coastline. Because of the cold climate there, it is very difficult process for the nature to adapt and recover. Exxon still uses single-hull tankers and the total cost for the company was just about 500 million $. Exxon employs about 75000 people. In the Europe is represented by its gas station brand Esso (ExxonMobil, company history, 2014).

Royal Dutch Shell plc

Commonly known as *Shell*, is an Anglo–Dutch multinational oil and gas company headquartered in the Netherlands and incorporated in the United Kingdom. Created by the merger of Royal Dutch Petroleum and UK-based Shell Transport & Trading. Shell topped the 2013 Fortune Global 500 list of the world's largest companies. Royal Dutch Shell revenue was equal to 84% of the Netherlands' $555.8 billion GDP at the time. About 92000 people is employed by Shell all over the world. Shell is its worldwide brand of gas stations (Wikipedia, Royal Dutch Shell, 2015).

Total SA

Is a French company, its headquarter is located in Paris and the company employs about 100000 people in all industries connected with oil or gas. In Europe is represented by gas stations Total and Elf (Total, About us, 2014).

Statoil

Is a Norwegian oil and gas company headquartered in Stavanger, Norway. It is not one of the biggest company, but it is the one which was represented in the research. It is a fully integrated petroleum company with operations in thirty-six countries. By revenue, Statoil is ranked by *Forbes Magazine (2013)* as the world's eleventh largest oil and gas company and the twenty-sixth largest company, regardless of

industry, by profit in the world. The company has about 23,000 employees. In Europe is represented by the gas stations Statoil (StatOil, About us, 2014).

Gazprom

Is a Russian company which is the biggest producer of a natural gas in the world, selling it mostly in Central Europe and Eastern Europe. Gazprom is also holding about 5% market share in the USA. Next to the gas production, they are as well producing and distributing crude oil. They are planning to start oil production in Bolivia (Gazprom, About us, 2015).

Security forces

Training on the simulators could be used by security forces as well so they know what to do in a case of emergency. There could be special trained forces for this kind of operations and situations and they could even higher the security and safety awareness by its cooperation with the crew.

Army simulations- specialized army forces and troops can also be used in case of emergency, they can help to lower damages with its equipment and training. Also subsea operations could be used by some kind of army protective related operations. Some defensive facilities can be installed on the sea bottom using subsea services.

Geographical locations

Subsea operations take part all over the world where offshore activities are now, or will be in a future. To have a subsea operation simulator in the nearby area of a real subsea operations would on one side save time and money for the customers, on the other side it would cause higher profit for the OSC as the simulators would be more used. The future is very open and drilling will take place even in areas where now it is not possible or it is possible just for some period of time. Few years ago they were not able to work all year long on the north of Norway, but now they are. It shows how can be locations changed quite fast. There will be new challenging projects run all around the world. In the future also some projects will take place in ice covered area, which is demanding for some special tools.

Europe

In Europe the main area are Nordic and Baltic Sea. In the north of Europe very active are The United Kingdom, Norway, Dennmark and partly Germany.

Exploration and development activities began in the southern part of the Norwegian Continental Shelf in the 1960s. Subsea developments started out as tie backs to existing platforms, which is still the case for smaller developments. However, dedicated floating units (FPSO, semi, etc.) as hosts have become more prevalent for new and stand-alone developments and are solutions for greater water depths. For gas fields, "subsea to shore" developments have become attractive. Such is the case with the StatoilHydro Ormen Lange, which utilizes this solution in 800 to 1,000 meters water depth and 120 km from shore (World Ocean Review, 2015).

Due to maturity of the region, many operators have been focusing their resources on increasing recovery rates from existing fields and implemented subsea tie backs for marginal new fields to existing platforms and floating facilities. Subsea separation, boosting and water-injection techniques are also becoming more widely adopted to increase field recovery rates.

The majority of North Sea developments are small subsea tie-backs to fixed platforms or FPSO units.

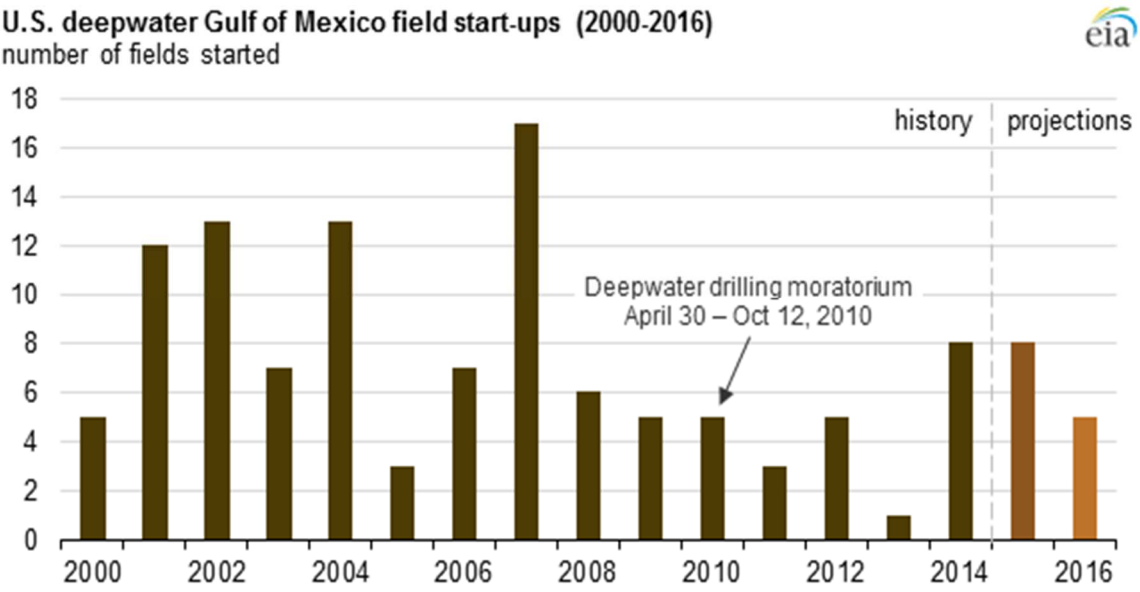
Gulf of Mexico

Throughout the history of the oil and gas industry, the Gulf of Mexico has continually presented some of the world′s most promising field discoveries. This trend has been driven most recently by rapid growth in the deepwater sector. As subsea technology has progressed to make deepwater fields both technically feasible and cost-effective, the Gulf of Mexico has become a focal point for such developments.

Development in Gulf of Mexico was hardly influenced by the Deepwater Horizon problem in 2010. Because of the explosion and oil spill in the sea, it was forbidden to start any other new projects till the end of year and the production on current one in the nearby area was decreased. While the moratorium officially lasted from April

30 to October 12, 2010, there were relatively few field start-ups in 2011 through 2013 (U.S. Energy Information administration, 2014).

That is why relatively high number of start-up projects is planned till the end of 2016 - thirteen projects and eight from them is planned to be a subsea facility or subsea tieback.



Source**:** U.S. Energy Information Administration

Figure 4 deepwater Gulf of Mexico field start-ups (2000-2016)

South America

The Brazilian oil and gas production is regionally concentrated in the states of Rio de Janeiro, Espirito Santo and Sao Paulo, which are located in the major hydrocarbon basins of Campos, Espirito Santo and Santos, respectively. Recent impressive reservoir discoveries in the subsalt layer of those basins are a promising exploration frontier for Brazil. According to analysts, Brazil will account about 32% of deep and ultra-deep water of worldwide production between now and 2018 (FMC, South America, 2014).

Petrobras is the main operator in Brazil, and a majority of the production is from offshore fields such as Roncador, Marlim and many others. Petrobras has approximately 600 subsea wells mostly composed of subsea trees.

Shell and Chevron are the first international oil companies to develop deepwater fields in Brazil.

Statoil and state-owned entity Petronic are looking to collaborate on joint oil and gas activities offshore Nicaragua's Pacific coast. They have submitted a request to the country's Ministry of Energy and Mines to negotiate concession contracts in the region

Southern Asia, Australia

The Asia-Pacific region of subsea activity is mainly concentrated in Australia, China, Indonesia, Malaysia and Vietnam; however, other countries such as India, Korea and the Philippines have had some activity. The Asia-Pacific region has the least number of installed subsea completions, but is the region with the highest growth rate (World Ocean Review, Oil and gas from the sea, 2014).

Although there are some large field development projects in the region, most of the projects historically have been marginal shallow-water subsea developments under 400 meters with less than six wells. There are currently several deep-water large-well-count projects in the region either under development or in appraisal.

Africa

Most of the subsea projects in Africa are concentrated on the west coast of the continent. The majority of prospects are in Nigeria and Angola, but other nations such as Congo, Egypt, Equatorial Guinea, Ivory Coast, Libya, Mauritania and South Africa also have activity. North Africa is predominantly a gas market characterized by large-volume, low-well-count projects, and the West Coast is mainly the oil market, with large reservoirs and many subsea wells, including water-injection wells in water depths in excess of 1,000 metres (FMC, Africa, 2014).

Mainly subsea tiebacks tied to FPSOs are used in this area. There is certain interest in subsea boosting technology, because of the low pressure in the African wells.

North Africa (Egypt and Libya) is predominantly a gas market characterized by large volume low well count projects that are tied back either directly to shore or through an intermediate host platform.

The most active operators in the Africa Region are Total, ExxonMobil, Chevron, BP, Shell, Amerada Hess and ENI.

5 Recommendations for Offshore Simulator Centre

For the future success of OSC is very important to build up an subsea simulator using some attachable ROV tolls, for this purpose state of the art tools should be used, it means to cooperate with some company from the current subsea operations. This will be same as cooperating with Rolls Royce. The usage of subsea operations in current offshore activities is growing very fast and it is the future trend. OSC has a big advantage in a fact that they already have other simulators so they are able to connect them all together. This will create a unique environment where different crews from different sea tasks could cooperate and train together because the communication is very important, especially with higher volume of external companies operating offshore.

Once when the simulator is done, the appropriate course has to be made and tailored for the possibilities of the simulator, moreover to be tailored for the needs of companies and operations. Pre-operation training is something which is highly demanded now on the market, companies want to try out the advanced operations with no risk of economical or environmental damages and loses.

Trainings should be more customized for needs of the clients as every operation is slightly different and also every crew is different. There are companies operating in different sub-industries, which need the training for its crew as well. Current trainings are not bad, but some parts which are not directly related to the crew's operation are for them boring. This could be bettered by different situations and giving obstacles, e.g. for better understanding how important communication is could be part of the training run without talking or to let someone play his role with a negative attitude.

The cooperation with AAUC and with other universities is also very helpful for both sides and using simulators already during studies makes the students better candidates for advanced offshore operations. Currently the industry is facing to a lack of well prepared and educated people for subsea operations, in this case the simulator can help, because the training will be more available for higher amount of students. Simulators can be used in different fields of studies, primary in the nautical

studies, but in ship design or simulation as well. Also future cooperation with marine high schools is the way where to go, because now there is no high school to use the simulators during education.

Providing the courses for companies operating in this industry is of a high importance, as the courses are needed during all working life in offshore. Those courses improve the moral of a crew and it helps to work better together.

Courses focused on crisis management are another way where to go. It showed that during crisis companies have problems to suddenly operate and react. This course would not teach how to forego to the crisis but how to manage it when it happens and minimize its damages. Together with the new safety regulations and use of simulators, it can really improve the safety offshore.

6 Conclusion

This thesis was written on a base of the research during my international study experience. In this research, I was supported by an Aalesund University College and Offshore Simulator Centre. As a method of gathering information were used interviews with people from offshore companies, Farstad and Statoil. In the beginning of thesis is explained theoretical how to do a research, what tools can be used. Then is explained the Offshore Simulator Centre, offshore activities and background of oil production, which is important for better understanding of a topic. In the end are mentioned possible business opportunities for offshore simulators including subsea simulator as well.

As a method of gathering data were chosen interviews and observation. Observation was used during the course of PSV crew, when I was observing crew's behaviour during operating a simulators and running case studies. The possibility to try out different positions and operations on the vessel, which is not possible in real life, showed an importance for the moral of the crew.

From the interviews with 4 people from two companies I got useful information, about the future in subsea, which I used for the purpose of the thesis. It took some time to gain at least basic information and be able to interview people about this topic, but thanks to the support what I had from OSC and especially from Jon Ivar Håvold, professor at AAUC I gained all the necessary information to conduct the interviews.

According to the interview I realized that there is a big potential in subsea, because subsea is a future trend in the offshore activities. The trend of subsea operations is growing very fast and for many companies it means a lot of new investment. Tasks in subsea and also offshore will be more and more difficult and it means that more highly skilled, educated and experienced people will be needed in near future. In the next 5 years will be subsea operations used basically for different kind of inspections and maintenance, which is needed now on current rigs, platforms, anchors, pipelines and pumps. In few years there will be a lack of skilled people to run subsea operations because the market is growing very fast. For educational organizations

it means a possibility to gain a new people or requalify them from current people. This could be very important in future. For subsea is needed same kind of education and competence, just with some smaller improvements directly for subsea. Attitude to be open, communicative and team player is same important as it is now in casual offshore operations.

There are some problems and obstacles, especially with this lack of educated people, than there is off course environmental risk and equipment damage. To avoid these problems, the appropriate training and right communication is needed. Communication was mentioned as very important factor in this sector, because there are working more teams together, it is not just about one crew, but there is a crew from ship and also a crew from ROV. Also the fact that operations will take place in different areas of the world, more areas than it takes place now. The communication and also culture understanding will be the key elements of a success.

The fact that the consumption of oil is increasing year on year means that oil fields are being exhausted faster than it was expected. There are new ways how to get out of a field more oil than in previous years, called fracking, but again this will satisfy the increasing demand for several future years. But when those relatively easy accessible fields are exhausted, the industry will face to a challenge, to get the oil from more difficult fields and areas, which is why subsea is of such an importance for this industry.

OSC should develop a ROV simulator to be able provide subsea operations simulator and strengthen their good position on the simulators market. They have really advanced software so it means that software needs just some add-ons, for example configuration of water. It should be able to make different water settings to simulate different seas and different depths, because the operations in a near future will go to the depth about 3000m, the current subsea facilities are mainly located in a depth of 300m. This would give them the great possibility to keep themselves as a market and innovative leaders.

There is a strong potential in subsea operations simulators as this industry is growing very fast all over the world where current offshore activities take place now

or will take in the future. Those simulators can be used in the cooperation with different universities to prepare the students for subsea operations because they will be highly demanded by the market in few years. Other opportunity is to use simulators in cooperation with offshore companies and run a trainings for their current crews, because it is needed to be aware of different situations which can happen on the sea. Very important is, as well, the use of simulators for security forces and rescuing companies, because in a case when something happens it is very important to be fast and accurate with the rescuing operations. Deepwater Horizon is a nice example of how it should not look like. It cannot take three months to stop the relieving oil in case of an accident. If a proper simulator would exist, it would be easier for engineers to try out the installation of rescuing cage.

To built up a subsea simulator is an expensive thing, but proper training of the people working in subsea and offshore generally can reduce the possibility of an accident. It can as well lower the damages if an accident happens. Proper training can save people´s lifes, nature, environment and a lot of money. Offshore companies know that in this industry is not good to save money and skip the safety lectures and courses, companies rather go for a more expensive solution which is more reliable. The same is valid for its crew, companies invest money to their education just to be sure and have more reliable employees. Trainings on offshore simulators are not compulsory, but hopefully it will be in the near future.

7 Bibliography

(2014). Retrieved May 6, 2015, from Rolls Royce: http://www.rolls-royce.com/customers/marine.aspx

(2014). Retrieved May 6, 2015, from FMC Technologies: http://www.fmctechnologies.com/AboutUs.aspx

Aker Solutions, Who we are and what we do. (2015). Retrieved May 5, 2015, from Aker Solutions: https://www.akersolutions.com/en/Global-menu/About-us/Who-we-are-and-what-we-do/

Berg, L. B. (2007). *Qualitative Research Methods For The Social Sciences* (5th edition ed.). Boston: Pearson Education Inc. .

BP, at a glance. (2015). Retrieved May 6, 2015, from BP: http://www.bp.com/en/global/corporate/about-bp/bp-at-a-glance.html

Cameron technology, About us. (2015). Retrieved May 7, 2015, from Cameron Technology: https://www.c-a-m.com/company

Cleveland, C. J. (2010, December). *Deepwater Horizontal oil spill*. Retrieved from Encyklopedia of Earth: http://www.eoearth.org/view/article/161185/

Conoco Phillips Who we are. (n.d.). Retrieved May 7, 2015, from http://www.conocophillips.com/who-we-are/Pages/default.aspx

Dril-Quip, Company profile. (2015). Retrieved May 7, 2015, from Dril-Quip: https://www.dril-quip.com/about.html

ExxonMobil, company history. (2014). Retrieved May 7, 2015, from ExxonMobil: http://corporate.exxonmobil.com/en/company/about-us/history/overview

Farstad Simulations. (2013). Retrieved May 6, 2015, from Farstad Simulations: http://www.farstadsimulation.com

FMC, Africa. (2014). Retrieved from FMC Technologies: http://www.fmctechnologies.com/en/SubseaSystems/GlobalProjects/Africa.aspx

FMC, South America. (2014). Retrieved from FMC Technologies: http://www.fmctechnologies.com/en/SubseaSystems/GlobalProjects/South%20America.aspx

Gazprom, About us. (2015). Retrieved May 6, 2015, from Gazprom: http://www.gazprom.com/about/

Havyard About us. (2013). Retrieved May 6, 2015, from Havyard : http://www.havyard.com/investor-relations/company-information/

Hials-studies. (2014). Retrieved April 10, 2015, from Hogskolen i Alesund: https://www.hials.no/eng/Home/Studies

Chevron- Company profile. (n.d.). Retrieved May 7, 2015, from http://www.chevron.com/about/leadership/

International Subsea Consultants. (2012, July 4). Retrieved from http://www.internationalsubseaconsultantsllc.com/about

Kvale, S. (1996). *Interviews. An Introduction To Qualitative Research Interviewing.* California: SAGE Publications, Inc. 325 pages.

Malhotra, N. K. (2010). *Marketing Research an applied orientation- global edition.* New Jersey: Pearson Education.

Offshore Magazine. (2013). Retrieved April 17, 2015, from Offshore MagazineOil spill training center unveiled in Northern Norway: http://www.offshore-mag.com/articles/2014/12/oil-spill-training-center-unveiled-in-northern-norway.html

Offshore Magazine. (2013). Retrieved April 17, 2015, from Analysts forecast steady deepwater growth: http://www.offshore-mag.com/articles/print/volume-

74/issue-10/departments/global-e-p/analysts-forecast-steady-deepwater-growth.html 17.4.2015

OSC- world most advanced offshore simulations. (n.d.). Retrieved May 7, 2015, from http://offsim.no/

Shank, G. D. (2002). *Qualitative Research A Personal Skills Approach.* New Jersey: Pearson Education, Inc. 224 pages.

StatOil, About us. (2014). Retrieved May 7, 2015, from StatOil: http://www.statoil.com/en/About/InBrief/Pages/default.aspx

SUBSEA 7 Who we are. (2013). Retrieved May 6, 2015, from Subsea 7: http://www.subsea7.com/en/about-us/who-we-are.html

Top companies in the subsea oil and gas production market. (2014). Retrieved April 26, 2015, from Technavio: http://www.technavio.com/blog/top-companies-in-the-subsea-oil-and-gas-production-market

Total, About us. (2014). Retrieved may 7, 2015, from Total: http://www.total.com/en/corporate-profile/thumbnail/total-glance-fourth-largest-global-oil-and-gas-company-1

U.S. Energy Information administration. (2014). Retrieved April 17, 2015, from http://www.eia.gov/todayinenergy/detail.cfm?id=20192

Wikipedia, Royal Dutch Shell. (2015). Retrieved April 30, 2015, from Wikipedia.com: http://en.wikipedia.org/wiki/Royal_Dutch_Shell

Wilson, A. (2006). *Marketing Research An Integrated Approach* (2nd edition ed.). Gosport: Pearson Educational Limited. 432 pages.

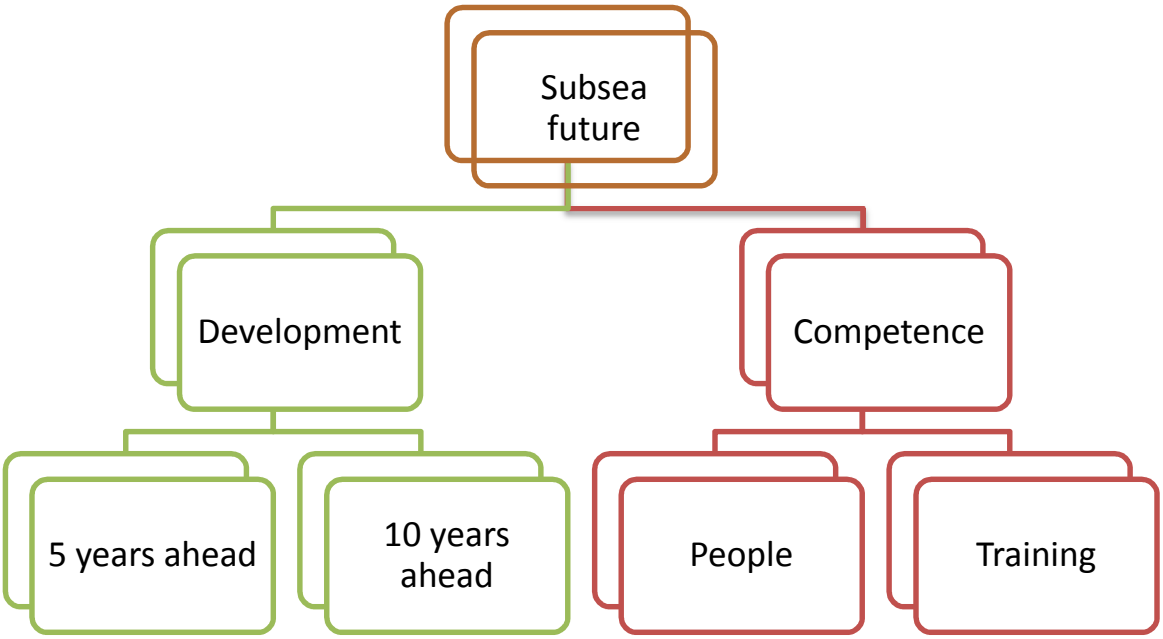
World Ocean Review. (2015). Retrieved April 10, 2015, from http://worldoceanreview.com/en/wor-3-overview/oil-and-gas/

World Ocean Review, Oil and gas from the sea. (2014). Retrieved April 4, 2015, from World Ocean Review: http://worldoceanreview.com/wp-content/downloads/wor3/WOR3_chapter_1.pdf

8 List of figures and table

List of appendices

Appendix 1 Interview Guide



1. Development:

- If we look 5 years ahead: What subsea operations do you see being carried out?
- If we look 10 years ahead: What subsea operations do you see being carried out?
- Where (geography) will the development be carried out?
- What are the main risks involved 5 years ahead; 10 years ahead?
- What will be the main obstacles to overcome the risks in the process? (5 years from now/ 10 years from now)
- Do you have any example of some operations?

2. Competence

If you look at the people working offshore today on ships and on rigs and their knowledge, skills and attitudes.

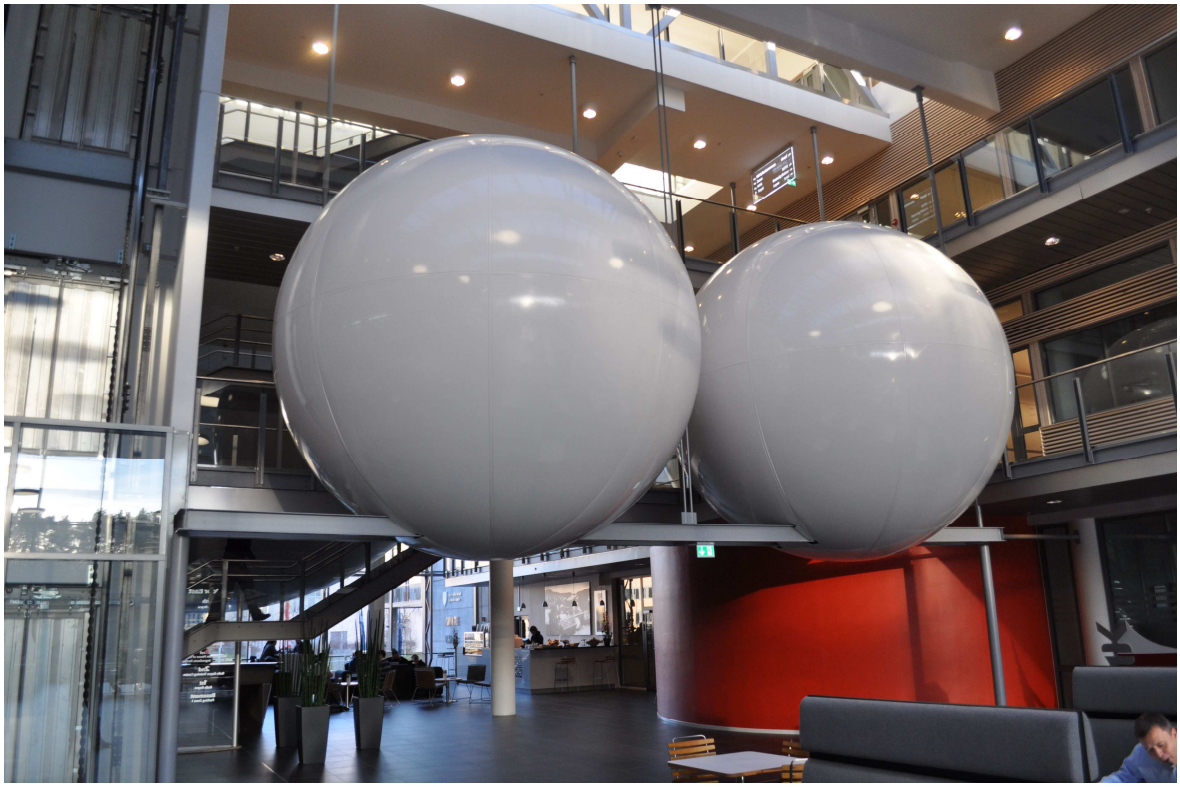
- What kind of competence (knowledge, skills and attitudes) do you expect is needed in connection with subsea operations the next 5 / 10 years? (Use Goleman “theory).
- Is it possible to recruit the kind of people you need from present educational institutions?
- What institutions?
- To be able to carry out the expected subsea operations in 2018 and 2023, what kind of training do you foresee is needed?
- What kind of training do you foresee will be in demand from subsea operators?
- Do you think preoperational training is important? If you have some task, you can first time try it on simulator and then on the sea.
- What you would understand under term training package (everything included-simulators, program, courses, cases, teachers)?
- Would you say that practical oriented course is more useful than theoretical?
- Does higher theoretical and practical knowledge influence security on sea?

3. General

- Will it be possible to say something about the market size for subsea operations in 2018 and 2023? (How many vessels; people etc)?
- What is needed for research and which results could the research show?

Appendix 2 View from the bridge simulator

Appendix 3 Two crane simulators in the NMK



Appendix 4 Bridge simulator in NMK

ANNOTATION

AUTHOR	JAN DVOŘÁK		
FIELD	**6208R087 Business Administration and Sales**		
THESIS TITLE	BUSINESS OPPORTUNITIES OF SIMULATORS FOR SUBSEA OPERATIONS		
SUPERVISOR	doc.Ing.JANA PŘIKRYLOVÁ, PhD		
DEPARTMENT	**KMM - Department of Management and Marketing**	2015	

NUMBER OF PAGES	60
NUMBER OF PICTURES	4
NUMBER OF TABLES	
NUMBER OF APPENDICES	4

SUMMARY	Main purpose of this thesis was to analyse situation in offshore simulation industry, especially with the interest in subsea operations. This topic was chosen because of Erasmus stay at our partner university in Norway where I did a research for OSC about the subsea future. Subsea is very growing trend and operations connected with subsea

	are very difficult and dangerous. Situation in subsea and in whole offshore industry can be improved by proper trainings of people working there. A proper training can lead to higher security offshore which is very demanded in this kind of industry. Moreover, simulators can help to lower damages in a case of accident.
KEY WORDS	Subsea, Offshore, Simulation, OSC, Offshore Simulation Centre, AAUC, Aalesund University College, Rolls Royce, Deepwater Horizon, Norway, Gulf of Mexico, ROV, FPSO
THESIS INCLUDES UNDISCLOSED PARTS: No	