Technical University of Denmark

DTU MEK & Nul-Kryds

Singapore 2016
Maritime Study Excursion

With a great thanks to our sponsors:
The Danish Maritime Fund
The Danish Society for Naval Architecture and Maritime Engineering's Fund
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Preface

The maritime student organization at DTU – Nul-Kryds – continuously strives for strengthening the link between the students and the maritime industry and for maintaining a good study environment. These focus areas should together with the maritime lectures at DTU form the basis for an attractive and unique entry to a career within maritime engineering. To build on that vision DTU MEK and Nul-Kryds sent 25 engineering students to Singapore in week 42 for an educational and motivating maritime study excursion organized by the president and vice president of Nul-Kryds.

By visiting major shipyards, site-teams, classification societies, maritime start-up companies and ship operators we all gained a much deeper understanding of maritime engineering and the technical challenges and opportunities related hereto. All are visits that encourages us to work even harder with our studies, as application of the education is made much clearer. In addition we met interesting people in the industry whom shared valuable knowledge about their career and choices. We am sure that those connections will benefit both the industry and the students in the future. Another important outcome of the excursion is the bonds that have been formed among the students – crisscross of year groups and study tracks. Not only have the daily exciting company visits been debated. Experiences on course plans, maritime student assistant jobs and future plans within the industry have been discussed and shared which unifies and enhances the network for the next generation of naval architects and maritime engineers.

The following pages summarize the student experiences from the excursion. Hopefully by reading it you will not question that the excursion have been highly valuable for all of us and that we have become motivated more than ever to continue our ambitions for a career within the maritime industry. At last we would like to show our greatest gratitude towards our funders:

- The Danish Maritime Fund
- The Danish Society for Naval Architecture and Maritime Engineering's Fund
- Thranes Fund

On behalf of the 25 participating students

Jacob Johannesen and Matilde Andersen
President and Vice President of Nul-Kryds

Sunday

Upon arriving in Singapore we went directly to our hotel, situated on Orchard Road. As no company visits were planned this day, it had been decided that this day should be spend on sightseeing.

Figure 1: View of Pagoda street in Chinatown.

The Sightseeing started with a short walk to the subway, from where we went to Chinatown. In Chinatown we went through the small shopping streets, while looking for potential souvenirs. The houses in Chinatown, presented a sharp contrast to typical skyscrapers in the rest of Singapore. Departing Chinatown, we walked down to the waterfront at Clarke Quay. Here we went for at stroll that stretch all the way to Clifford Square, where we had a short break. From here it was possible to enjoy the view of our final destination; Marina Bay Sands.

Figure 2: Walk around Marina Bay.

After enjoying the view for a while, we walked to the bottom of the tower on the left. From here we took a lift to the top of the tower that had a bar serving cool beverages. We enjoyed the splendid view of Singapore and all of the ships laying at anchor in the Singapore Strait.

Figure 3: View from the terrace in Marina Bay Sands.

After having couple of drinks we went back to Clarke Quay to enjoy chili crab at a nice seafood restaurant.

Monday

The first day of the trip to Singapore started a bit later than the forthcoming coming days, so that the group had time to sleep in after 18 hours of travel and some minor jetlag. We started at 7.30 with breakfast at the hotel and afterwards the group boarded the bus which drove us to Tuas Shipyard in the south western part of Singapore – a good one hour drive where we got to see the streets of Singapore and glimpses of the industry going on along the shores.

We arrived at Tuas Shipyard at 09.00 where we were lead through security and into a meeting room where we had a security briefing and was shown the general layout of the shipyard. Hereafter the representatives from Maersk Oil introduced the Culzean project – a high-pressure / high-temperature gas field. Here a Floating Storage and Offloading (FSO) unit is supposed to be connected to a three bridged-linked platform; a wellhead platform, processing platform and an accommodation platform. The Japanese operator, Modec, is supplying the FSO and Modec subsequently hired Sembcorp Marine to design and build the FSO. The project and FSO is designed for harsh weather conditions in the North Sea and a 25 year lifetime on the sea without docking. The representatives from Maersk Oil were Malcolm Wilkie, a young process engineer who was overlooking the design of the FSO's topside. Claus Bonde, an educated naval architect from DTU, overlooking the general layout of the ship and Derek Patience who was supervising the production of the ship at the yard.

Figure 4: General presentations on ship design and shipbuilding.

After the general presentations, Malcolm did a presentation explaining the whole project in the North Sea at the newly discovered Culzean field, a large gas field 233 km off the coast of Aberdeen, and the challenges they faced at the field. The Culzean field is supposed to supply Great Britain with 5% of its natural gas demand. Thereafter he went on to explain that they needed the FSO to receive and store the oil product being produced as an excess product when extracting the gas, and how they processed it. He told that the FSO was included late in the project. Here it is notable that the American owned Danish company NOV Flexibles are delivering the flexible risers connecting to the turret of the FSO.

After this very interesting presentation, Claus Bonde continued with his presentation on the design of the ship. He was very in-depth with his explanations of how to design the mooring system, the moon-pool for the ingoing product and some of the other problems they had faced when designing a ship to last 25 years without docking in harsh environment of the North Sea. Especially fatigue life was stated as a major design criteria and Claus told us that they in Maersk uses 40-year fatigue life as design criteria based on previous experiences. The group was then welcomed to ask questions and seized that opportunity and got good technical answers from Claus Bonde. The final presentation was held by the production manager, Derek Patience. He explained and described the production challenges at the yard, their time schedule and how far they were in the process. The first steel for the FSO was cut in July and he explained that it was possible to see the beginning of the double-bottom hull, out in the yard.

After the three presentations, lunch was served at the manager's cafeteria, where a very delicious asian buffet was served along with dessert. The three representatives from Maersk Oil joined us to talk further about working at the yard, the Culzean project and Singapore in general. After lunch we were all equipped with full PPE gear; boots, helmets and glasses that we had to wear during our yard tour. We were then divided into two groups where one group was led by Derek Patience and the other was led by Ian Bentley, one of Derek's associates. At the yard, we saw the double-bottom hull for the FSO, ongoing welding work and maintenance work of other ships and semi-submersible. Claus Bonde and Malcolm Wilkie were also attending the tour and they answered questions along the way and explained the different procedures. We went around the yard for 2 hours and were allowed to take pictures. After the tour we returned to the office to change back to our normal clothes. When everyone was gathered, Jacob, our union president, spoke for all of us, thanking the Maersk Oil people for an exciting tour and gave them a small present as a token of our gratitude.

Figure 5: Group photo at Tuas Yard.

We then drove back to the hotel where we had one hour before meeting up again in the lobby to go for dinner. We all went for dinner at a very delicious food court, with an large selection of different kinds of food; Thai, Korean, Indian, Turkish, Chinese etc. One decided for himself what to eat and we sat in groups of approximately 10 people and enjoyed our meals.

Tuesday

The day started at 0700 for yet another brunch at the hotel. Hereafter the bus took the team to a quite young company in the industry, named C-leanship. Already before the arrival at the first company the temperature had risen well above 30 degrees, which definitely had an impact on the team members, some more than others.

The company C-Leanship is in the process of developing a Remote Operated Vehicle, ROV, which should be able to compete with the existing methods in the field of hull cleaning. The scope of the development is to create a safer and more efficient method for in-water hull cleaning. The ROV it-self is an approximately 2x2.5 meter submersible, which navigate with the help of developed software from SAAB. The software is given the geometrical properties of the hull and from these it is able to create an easy understandable picture of the cleaned area of the hull. For now the robot has the highest efficiency on larger hulls, however the maneuvering propeller system is under development, which will lead to better results at smaller vessels as well. In this moment C-leanship is capable of cleaning approximately 1500m2/h depending on the shape and size of the ship. It was great to hear how the start-up and development of a new product was conducted. It is stories like this that gives students like us the confidence to try and develop our own ideas and concepts for the benefit of the industry.

Figure 6: Presentation of hull cleaning robot at C-Leanship.

After the C-leanship presentation and walk-around the cleaning vessel we drove by the bus to our next visit in the shape of DAMEN Shipyard. At DAMEN we first got a presentation of the evolution of DAMEN Shipyard from the very start to the present. Hereafter we had a great lunch buffet, where we had the opportunity to talk to two of DAMEN Shipyard's interns from Delft University. They explained about some of the hands-on experience they had acquired both in regards to the shipbuilding process but also the everyday life as a foreign intern in Singapore. Finally we gut a walk-around the DAMEN Shipyard in which they have specialized in building fast ships, both in aluminum and steel and with catamaran hull and more conventional ship design

Figure 7: Aluminium hulls at Damen Shipyard.

In the evening we went to one of Singapore's famous small food courts, where we ate some traditionally Singaporean dinner. We closed the day off in the best possible way with live music and the traditional cocktail Singapore Sling served by, the only appropriate, the old Hotel Raffles.

Figure 8: Cheerful students enjoying a Singapore Sling at the place it was first created.

Wednesday

Visit to NUS

In the morning the group went to the National University of Singapore, Centre for Maritime Studies. There a presentation where given on their activities and the research conducted along with a tour around their marine test facilities.

The presentation had three key points:

- Introduction to study tracks, focusing on the possibilities of doing a full master or an exchange program at NUS.
- Current research being conducted focusing on arctic exploration and production and numerical modeling
- Presentation on the new model tank being constructed in Singapore in a joint venture with Nanyang Technological University and Keppel.

The tour around the test facilities gave access to lots of different equipment. On hydrodynamics a wave generating tank were on display along with the pride of the Maritime Centre, their coastal simulation tank. Further a tour was given into the material research lab were a lot of research was conducted in materials and production processes suited for arctic operation. A question of major interest for the students was the possibilities of actual involvement in the practical experiments, a question to which NUS replied positively and perhaps the foundation was made for future summer schools etc.

The visit ended with lunch at the university's food court, yet another possibility to enjoy the local cuisine, this time even at somewhat student-friendly prices.

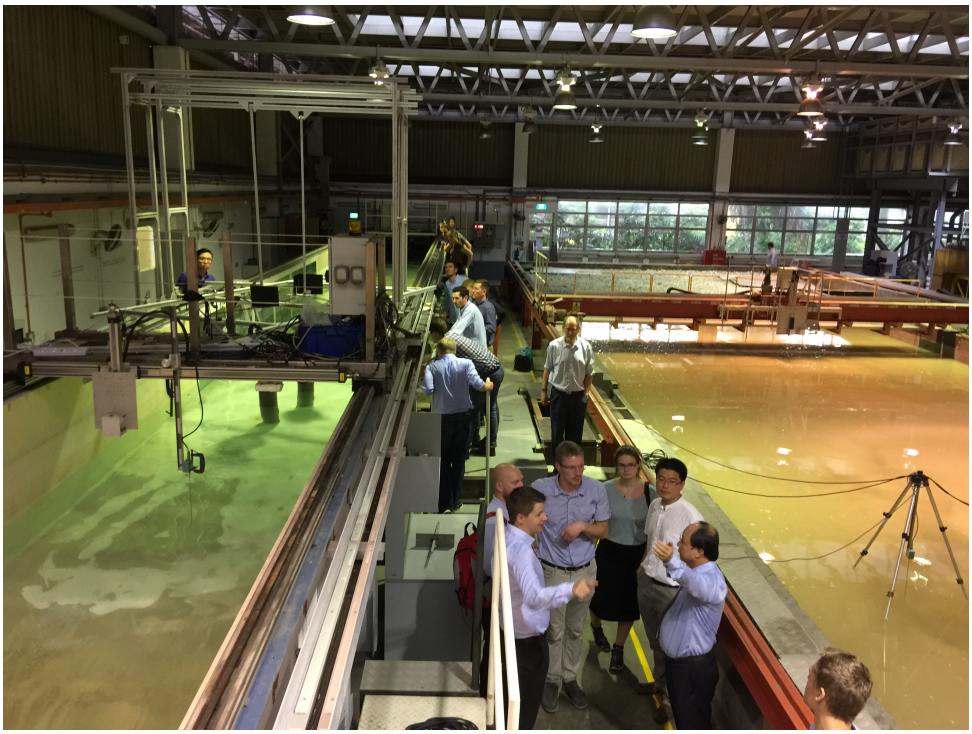

Figure 9: Test facilities at NUS.

Visit to Keppel

After the visit to NUS the tour continued at Keppel FELS, the largest of Keppel's seven locations in Singapore and specialized in the construction of Jack-up drilling rigs. First a brief introduction to Keppel as a company in general was given, with a further explanation of the four sections of Keppel offshore & marine:

- Offshore, drilling rigs
- Marine, general ship repair and conversions (FPSO, FSU, FLNG, FSRU)
- Specialized shipbuilding, supply boats, cable laying vessels etc.
- Technical development, providing the services of a design office.

Furthermore, an outline of the different locations capabilities was given; Keppel is not only located in Singapore but also in China, and other major oil hubs such as Angra dos Reis in Brazil, Rotterdam and Texas. Even though much of the steel work takes place in China, the R&D department is located in Singapore with a headcount of approx. 200 alongside the design department.

The FELS location alone can occupy up to 18.000 workers at the yard when production is at a maximum but is now employing 8-9.000 workers. At maximum capacity the FELS-yard can deliver 21 jack-up rigs a year (2013) with a process time for one rig of a little less than two years. For 2016 a total delivery of 8 new builds is expected and for 2017 a further decrease in production is anticipated. In total the turnover generated by Keppel FELS only was 1.8 billion USD in 2015.

After the introduction a one-hour long Q&A session was held with representatives from four different departments of Keppel, the R&D department, the Marine department, FELS representing offshore itself and the training department (HR). The Q&A covered many exciting topics and revealed some interesting opinions on the shipping market from a constructor's point of view. An overview of the most significant subjects and discussions will be given in the following.

Naturally the cooling of the offshore market due to the low oil price was a big theme. The Fels yard itself is measured on the utilized amount of manpower running at half capacity, but only utilizes about 1/3 of the newbuilding capacity. The difference in those two numbers are the capacity used on upgrades and repairs on existing rigs, a market that have seen a slight increase for Keppel. Something that the group would experience on Friday. The low oil price had made a much larger impact on the amount of specialized ships, and at some of Keppels other locations in Singapore the utilization of capacity had been reduced even further than at Fels.

During the discussion Keppel focused on the fact that they to some extent are not competing on price but on quality and delivering turn-key solutions and therefore has a solid base of regular clients. So regular clients that they actually allow them to postpone and even cancel already signed orders to keep the clients.

Apart from the effects of the current oil price automation and Keppel's research into that was also a major theme during the discussion. The discussion was based on the work with an automated drill floor and then went into more general discussions about autonomous ships.

Furthermore, Keppel revealed an interesting consideration about their future strategy especially within shipbuilding where they on a long term were investigating the possibilities of reducing their amount of own new builds. Instead Keppel would like to increase its activities as a design office and within quality management.

After the Q&A session a short guided tour was made around the yard by bus. It was clear that the capacity of the yard was fare from completely utilized but the size of the structures were impressing.

Figure 10: Q&A Panel at Keppel Fels.

Figure 11: The group in front of the yard.

Evening activities

After the visit the group enjoyed a seafood dinner at one of the channels in the old harbour located centrally in the city. The atmosphere was nice and the waterfront location made it possible to sit outside, a convenient change from the air-condition.

As the end of the program for the day the group went to 1-Altitude to enjoy a drink and the fantastic 360-degree view from the 280-meter-high building. The view of the lighted ships in the Singapore bay was truly amazing just as a laser/light show at the waterfront.

Figure 12: View from the bar 1-Altitude.

Thursday

The day started out with people meeting in the lobby, getting ready for trip. We left early, 6:45, by bus to avoid traffic. When we reached the border we were astonished by the amount of Malaysian people going into Singapore. The entire bridge crossing the river between Singapore and Malaysia was one large traffic jam. However, everybody got across the border and we arrived at PTP.

PTP is a container terminal, partly owned and operated by ATP, a part of Maersk Group. We spent the first half of the day at the office. After the safety induction, we were welcomed to the Maersk office by Siti Asma' Abd Gani who first gave a presentation of Maersk Line and afterwards a short description of the work carried out at the office.

Figure 13: The group in the office during one of the presentations.

A skype presentation of Ship Operations held by Varun Iyer Mani, Fleet Superintendent, in Singapore was delayed, so it was suggested that we just had a walk around the office to have a look and a talk with the employees at work that day. Everyone at the office was very forthcoming and we had the chance to scatter into smaller groups to chat with employees about what they were currently working on and in the process, get a couple of stories from life at a container terminal.

It was a very interesting experience to see this side of ship operations, and once again be reminded how international the shipping business is, and in relation to this how many different aspects must be considered once a vessel calls a harbor. As an example, one of the blackboards listed the countries that are currently victims of the Zika virus, and for which crews are quarantined until a health inspection has taken place. After the office mingling, the morning was concluded with the delayed presentation by V. Mani.

Figure 14: The view of PTP from the restaurant where we had lunch.

For lunch, we headed to a local restaurant and got a short glimpse of rural Malaysia, which with its small cottages stood in sharp contrast to Singapore. The food was delicious and it was nice with a break to discuss the impressions from the first part of the day. One of the tables were joined by a young naval architect, who had relocated from the Northern part of Malaysia to be part of a graduate program within the Maersk Group. This initiated a longer conversation about the options and pros of cons related to partake in an international program after graduation and perhaps also later relocate to somewhere out of Denmark. At the other tables staff from the commercial department and our host of the day.

Back in the office before we went out to the terminal and onboard Maersk Klaipeda a presentation about the commercial side of port management was given. This gave rise to several questions about the administration of such a big port, how to expand if needed and how to handle tidal waters to allow for the biggest vessels to call at PTP.

Once again we boarded the bus, this time for a guided tour around the harbor, first passing the free zone, where enormous warehouses are located, and then passing the railway which has been build specifically to accommodate for the transport of containers. We drove the full length of the quay and got a sense of how the cranes increased in size. Maersk Klaipeda was moored at the last quay berth and even though the size of the port made it seem like we parked right next to it, we still had to cross multiple lanes before we were at the gangway.

Figure 15: The group exploring the workshop while waiting to go into the engine room. We went in in smaller groups so everybody was able hear.

Onboard Maersk Klaipeda we were met by the chief Marine Engineer who showed us the engine room and the central switchboards. Afterwards we headed up to the bridge where we were given a brief description of all the navigation equipment. At the end of the tour we headed up to monkey island from where we had an amazing view of the terminal and a chance to see how fast a process the loading and unloading of containers is – And of course the mandatory group picture was taken here.

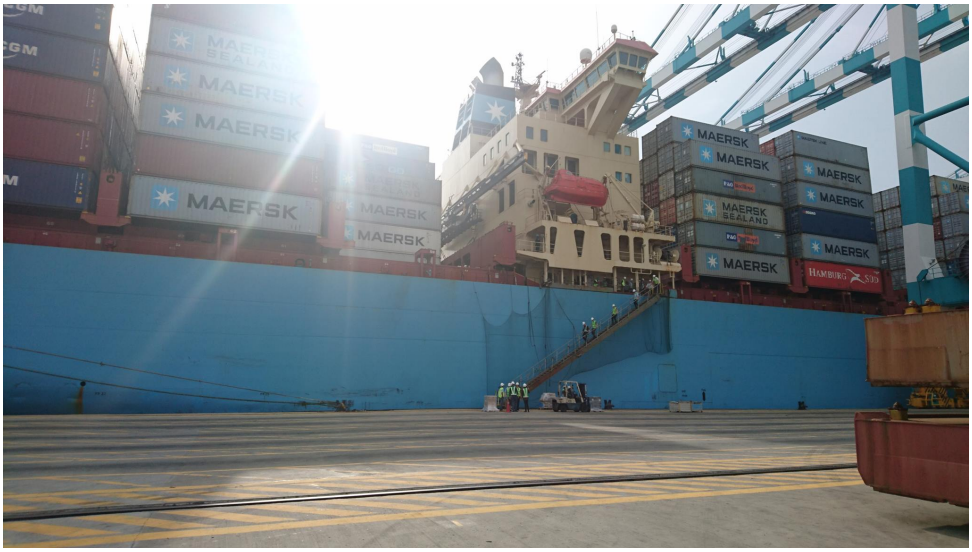

Figure 16: The group about to board Maersk Klaipeda.

Back at the office we only had time to leave our PPE and thank the hosts for a well-planned day with loads of new impressions. As we were about to cross the border we were shocked to see the huge queues of Malaysian workers leaving Singapore, when we asked the guide, we were told that it was most likely the same people we had seen heading into Singapore as we were leaving in the morning.

We stopped by the hotel to change into some cooler clothes before heading out to the local food courts.

Figure 17: The group onboard Maersk Klaipeda.

Friday

Maersk Drilling

The day started out with a visit to Keppel FELS Shipyard, where the group visited Maersk Drilling's jack-up rig MAERSK CONVINCER. The rig has been out of an active contract since the beginning of November and is currently undergoing routine maintenance work.

Figure 18: Maersk Convincer visited at Keppel FELS.

The rig was built in 2008 and is capable of drilling at sea-depths down to ca. 114 meters. The rig can accommodate a crew of up to about 115 people. Since the rig is currently out of operations, the current compliment is only 15 crew members. It was interesting to learn about how the current oil and gas market influences the maintenance budget and thereby the work-scope on board the rig.

Figure 19: Tool-pusher Niek showing the drilling equipment.

Aboard the rig the group was shown around by chief engineer Kris and the Tool-pusher Niek. Kris showed us the Accommodation areas as well as the engine room and lower deck machinery spaces. Niek showed us the main deck equipment, drilling area as well as the jack-up mechanism.

Figure 20: Tool-pusher Niek explaining the sequence of drilling operations to the students.

The visit was a great learning experience and was a unique possibility to ask experienced engineers about the life on board a Maersk drilling rig. We gained insight into the different jobs on board as well as the technicalities of the complex drilling operations. Niek and Kris were very welcoming and shared some very interesting insights into how the crew interacts with the shore management to prepare and execute drilling operations.

Lloyd's Register

Friday afternoon the group had lunch together at a great food court close to Lloyd's Register's Global Technology Centre. At the GTC the group was introduced to the history of the Centre and how it operates under a contract with the Singaporean government by the head of the GTC. After the initial introduction, three employees presented their current projects and research topics.

The first to presentation was held by the leading research naval architect. The presentation focused on the development of an in-house software tool to assist LR customers to conduct rule based and analytical structural design. Among these developments, the new Finite Element Modeling (FEM) software tool seems to be the main focus. LR is also investigating how to better integrate FEM and CFD into the design process. By doing so, LR hopes that errors can be found earlier and more easily in the design process. As a closing remark the group was presented LR's concept for the phase-development of autonomous shipping.

Figure 21: The Head of GTC explaining the focus areas of research and current projects.

The second presentation focused on numerical wave-load predictions by developing a more precise CFD simulation of a Numerical Deepwater Basin. This project is a collaboration between Lloyd's Register, NUS and IHPC. The CFD simulation uses the open source program OpenFoam. One of the main reasons LR is conducting this research is to investigate problems associated with inadequate air-gaps on offshore platforms. Recent incidents have shown that a better understanding of non-linear effects is required. In this regard LR is investigation the application of the 'new wave theory' developed to simulate focused wave peaks.

The third presenter talked about a project he was doing in collaboration with a professor at DTU. This project aims to apply academic theory in practical commercial applications to estimate scouring effects. By using a hybrid scour model, which is less precise than a full simulation, less computational resources are required and simulation time is drastically reduced. The commercial incentive is to increase simulation accuracy in order to reduce model testing during the design process and therefore increase the efficiency. The current computational method is a full scour model which can take up to 2 months to compute. The project is still under development but has shown promising initial results.

It was particularly interesting to see how complex academic models can find their way in practical applications through clever engineering. The presentations quickly developed into an interactive discussion between ourselves and the LR staff. It was a great learning experience and fun exchange of ideas.

Figure 22: Students with the GTC research team.

After the visit to Lloyd's Register the group went to a Brazilian barbeque restaurant for dinner to enjoy the last evening in Singapore. In good spirits and with great food the impressions of the week were recollected and discussed.

Figure 23: Final dinner at a Brazilian Barbeque restaurant in Chijmes.