MASTER'S PROGRAMME

OFFSHORE & DREDGING ENGINEERING

FACULTY OF MECHANICAL, MARITIME AND

MATERIALS ENGINEERING

DELFT UNIVERSITY OF TECHNOLOGY

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This report was finalized on 26 March 2019.

REPORT ON THE MASTER'S PROGRAMME OFFSHORE & DREDGING ENGINEERING OF DELFT UNIVERSITY OF TECHNOLOGY

This report takes the NVAO's Assessment Framework for Limited Programme Assessments as a starting point (September 2016).

ADMINISTRATIVE DATA REGARDING THE PROGRAMME

Master's programme Offshore & Dredging Engineering

Name of the programme:	Offshore & Dredging Engineering
CROHO number:	60178
Level of the programme:	master's
Orientation of the programme:	academic
Number of credits:	120 EC
Specializations or tracks:	- Bottom Founded Structures, Arctic Engineering & Offshore Wind - Dredging Engineering, Trenching, Deep-Sea Mining & Subsea Engineering - Floating Offshore Structures - Structural Design & Analysis
Location(s):	Delft
Mode(s) of study:	full time
Language of instruction:	English
Expiration of accreditation:	31/12/2019

The visit of the assessment panel Mechanical Engineering to the Faculty of Mechanical, Maritime and Materials Engineering of Delft University of Technology took place on 13 and 14 December 2018.

ADMINISTRATIVE DATA REGARDING THE INSTITUTION

Name of the institution:	Delft University of Technology
Status of the institution:	publicly funded institution
Result institutional quality assurance assessment:	positive

COMPOSITION OF THE ASSESSMENT PANEL

The NVAO has approved the composition of the panel on 20 August 2018. The panel that assessed the master's programme Offshore & Dredging Engineering consisted of:

- Prof. dr. K.G.S. (Sören) Östlund, professor of Packaging Technology at the Department of Solid Mechanics of the KTH Royal Institute of Technology (Sweden) [chair];
- Prof. dr. H.J. (Henry) Rice, professor in Mechanical Engineering and head of the School of Engineering of Trinity College (Ireland);
- Dr. M. (Maddalena) Velonà, coordinator of studies at the Department of Mechanical and Process Engineering (D-MAVT) at Eidgenössische Technische Hochschule (ETH) Zürich (Switzerland);
- Drs. J.J. (Jan) Steen, consultant Quality of Education at Wageningen University & Research;
- Prof. dr. R.W. (Richard) Birmingham, professor in Small Craft Design at the Marine Technology Group of the School of Engineering, Newcastle University (United Kingdom);
- Ir. J. (Jan) Leideman, new business development manager at DEMCON Advanced Mechatronics;
- A.J. (Alicia) Knijnenburg, BSc, master's student Mechanical Engineering at the University of Twente [student member].

The panel was supported by dr. B.M.(Barbara) van Balen, who acted as secretary.

WORKING METHOD OF THE ASSESSMENT PANEL

The site visit to the master's programme Offshore & Dredging Engineering at the Faculty of Mechanical, Maritime and Materials Engineering of Delft University of Technology was part of the cluster assessment Mechanical Engineering. In December 2018 the panel assessed eleven programmes at three universities. The following universities participated in this cluster assessment: Delft University of Technology, Eindhoven University of Technology and the University of Twente.

On behalf of the participating universities, quality assurance agency QANU was responsible for logistical support, panel guidance and the production of the reports. Dr. Alexandra Paffen was project coordinator for QANU. Dr. Barbara van Balen acted as secretary in the cluster assessment. She is a certified NVAO secretary.

Panel members
The members of the assessment panel were selected based on their expertise, availability and independence.

Preparation
On 9 December 2018, the panel chair was briefed by QANU on his role, the assessment framework, the working method, and the planning of site visits and reports. A preparatory panel meeting was organised on 9 December 2018. During this meeting, the panel members received instruction on the use of the assessment frameworks. The panel also discussed their working method and the planning of the site visits and reports.

The project coordinator composed a schedule for the site visit in consultation with the Faculty. Prior to the site visit, the Faculty selected representative partners for the various interviews. See Appendix 4 for the final schedule.

Before the site visit to Delft University of Technology, QANU received the self-evaluation reports of the programmes and sent these to the panel. A thesis selection was made by the panel's chair and the project coordinator. The selection existed of fifteen theses and their assessment forms for the programmes, based on a provided list of graduates between 2015-2017. A variety of topics and tracks and a diversity of examiners were included in the selection. The project coordinator and panel chair assured that the distribution of grades in the selection matched the distribution of grades of all available theses.

After studying the self-evaluation report, theses and assessment forms, the panel members formulated their preliminary findings. The secretary collected all initial questions and remarks and distributed these amongst all panel members.

In the evening before the site visit, the panel discussed its initial findings on the self-evaluation reports and the theses, as well as the division of tasks during the site visit.

Site visit
The site visit to Delft University of Technology took place from 13 to 14 December 2018. During the site visit, the panel studied the additional documents provided by the programmes. An overview of these materials can be found in Appendix 5. The panel conducted interviews with representatives of the programmes: students and staff members, the programme's management, alumni and representatives of the Board of Examiners.
The panel used the final part of the site visit to discuss its findings in an internal meeting. Afterwards, the panel chair publicly presented the panel's preliminary findings and general observations.

Consistency and calibration
In order to assure the consistency of assessment within the cluster, the following measures were taken:

1. The panel composition ensured regular attendance of (key) panel members, including the chair;
2. The secretary was present at the start of all site visits as well as the panel discussion leading to the preliminary findings at all site visits of Delft University of Technology, Eindhoven University of Technology and the University of Twente.

Report
After the site visit, the secretary wrote a draft report based on the panel's findings and submitted it to the project coordinator for peer assessment. Subsequently, the secretary sent the report to the panel. After processing the panel members' feedback, the project coordinator sent the draft reports to the Faculty in order to have these checked for factual irregularities. The project coordinator discussed the ensuing comments with the panel's chair and changes were implemented accordingly. The report was then finalised and sent to the Faculty and University Board.

Definition of judgements standards
In accordance with the NVAO's Assessment framework for limited programme assessments, the panel used the following definitions for the assessment of both the standards and the programme as a whole.

Generic quality
The quality that, in an international perspective, may reasonably be expected from a higher education Associate Degree, Bachelor's or Master's programme.

Unsatisfactory
The programme does not meet the generic quality standard and shows shortcomings with respect to multiple aspects of the standard.

Satisfactory
The programme meets the generic quality standard across its entire spectrum.

Good
The programme systematically surpasses the generic quality standard.

Excellent
The programme systematically well surpasses the generic quality standard and is regarded as an international example.

SUMMARY JUDGEMENT

Standard 1
The master's degree programme Offshore & Dredging Engineering (ODE) is provided by the Faculty of Mechanical, Maritime and Materials Engineering (3mE) and the Faculty of Civil Engineering and Geosciences of Delft University of Technology (TU Delft). It focuses on the design and operation of all fixed and floating structures in the offshore marine environment. The programme has a strong interdisciplinary character based on marine, mechanical and civil engineering, with extended use of control engineering, electronics, telematics, logistics and informatics. In line with this profile, the programme formulated intended learning outcomes (ILOs).

The panel established that the ILOs indicate the content, level and orientation of the master's programme ODE and match the professional field. The current ILOs definitely meet the standard. The panel finds the topic of this programme of great potential and growing importance. It is a unique programme due to the combination of Offshore & Dredging Engineering. To keep the programme future-proof, the panel encourages further evaluation and adjustment of the programme and including, if necessary, revision of the ILOs.

Standard 2
ODE offers four specialisations: Bottom Founded Structures, Arctic Engineering & Offshore Wind; Dredging Engineering, Trenching, Deep Sea Mining & Subsea Engineering; Floating Offshore Structures; Structural Design & Analysis. The first year of the programme consists of 6 obligatory courses worth a total of 24 EC, a project of 6 EC, specialisation courses of about 15 EC and several electives worth 15 EC. Most of the second year of the programme is devoted to the graduation project (45 EC). The goal of the second year is to let students work individually on a complex problem, while independently using the tools and methods they have been provided, to develop new theory and design methods to solve complex ODE problems. Students must carry out a literature survey of about 15 EC and work on a thesis project of 30 EC on one topic. The programme uses a variety of teaching strategies: lectures combined with homework assignments, research, projects, self-study, literature survey and thesis project.

The panel established that the curriculum enables the students to achieve the ILOs. It found the curriculum to be well structured; there is a good alignment between the ILOs and the curriculum. It appreciates the highly interdisciplinary character of the programme and the solid basis of ODE knowledge provided by the well-chosen obligatory courses. It noticed a close cooperation and contact with industrial stakeholders, which also adds to the quality of the programme.
The quantity and quality of the teaching staff meet the standard, and the lab and study facilities of the programme are good.

Standard 3
The Faculty aims to achieve a high level of quality in its teaching and assessment. The Faculty's assessment system and policy are well developed and properly implemented according to the panel. All teachers are aware of the policies and measures implemented to assure the validity and reliability of the assessments. The Faculty has ensured that the teachers are supported in their tasks by the appointment of an educational advisor.

The courses use a variety of assessment methods, which are very well aligned, with the help of the matrices, with the learning outcomes and the curriculum. The procedures are transparent for teachers and students.
The panel is very positive about the way the Board of Examiners is performing its tasks and concluded that the examinations, tests and the thesis assessment are transparent, valid and reliable.

Standard 4
The panel studied a selection of 15 master's theses to assess whether the graduates had achieved the intended learning outcomes. It found the level of the theses to be good. It concludes that

graduates of the master's programme Offshore & Dredging Engineering have achieved the intended learning outcomes. They are well prepared for continuing in a PhD trajectory or a career in industry.

The panel assesses the standards from the *Assessment framework for limited programme assessments* in the following way:

Master's programme Offshore & Dredging Engineering

Standard 1: Intended learning outcomes	satisfactory
Standard 2: Teaching-learning environment	satisfactory
Standard 3: Student assessment	good
Standard 4: Achieved learning outcomes	good
General conclusion	good

The chair, prof. dr. Sören Östlund, and the secretary of the panel, dr. Barbara van Balen, hereby declare that all panel members have studied this report and that they agree with the judgements laid down in it. They confirm that the assessment has been conducted in accordance with the demands relating to independence.

Date: 26 March 2019

DESCRIPTION OF THE STANDARDS FROM THE ASSESSMENT FRAMEWORK FOR LIMITED FRAMEWORK ASSESSMENTS

General remarks cluster Mechanical Engineering

This report constitutes part of the limited programme assessment of the NVAO Assessment cluster Mechanical Engineering representing 11 bachelor and masters programmes in Mechanical Engineering, Automotive Technology, Marine Technology, Offshore and Dredging and Materials Science and Engineering at University of Twente, Eindhoven University of Technology and Delft University of Technology. The findings for each programme are based on the self-evaluations performed by each programme and site visits taking place on December 10-14, 2018.

In the self-evaluation reports and during the site visits, the evaluation panel has encountered many knowledgeable and dedicated programme managers, skilled and engaged teachers, well-educated and enthusiastic students and successful alumni. It is therefore with great pleasure that we can conclude that the overall outcome of the evaluation panel ends on a positive note.

All programmes are based on intended learning outcomes well set in national or international perspective of the requirements currently set by the professional field and the discipline, programme managers, teachers and students work hard to create a motivating and dynamic teaching and learning environment, all programmes have elaborated assessment plans and the achieved learning outcomes are good. Many of the theses read by the evaluation panel are indeed of very high quality, and graduates from the eleven programmes in general have very good career opportunities.

There is of course always room for improvements, and, particularly, the processes around internships, the overall study times and the high dropout rates are areas that should be given continued high attention. The increased internationalisation of the programmes, the growth in number of students and the level of the students are other challenges that needs consideration in the coming years. However, it is the opinion of the assessment panel that the programmes in the Assessment cluster Mechanical Engineering are well prepared to meet these.

On behalf of the Mechanical Engineering assessment panel,
Sören Östlund (Chair)

Governance structure of the Faculty

The master's degree programme in Offshore & Dredging Engineering (ODE) is provided by the Faculty of Mechanical, Maritime and Materials Engineering (3mE) and the Faculty of Civil Engineering & Geosciences (CiTG) at Delft University of Technology. The Faculty 3mE coordinates the programme. This Faculty offers the ODE programme, the bachelor's and master's programmes Mechanical Engineering, the bachelor's and master's programmes Marine Technology, and the master's programme Materials Science and Engineering, which are also assessed in this cluster. The Faculty also offers the bachelor's and master's degree programmes Technical Medicine and the master's programmes Biomedical Engineering and System and Control.

Standard 1: Intended learning outcomes

The intended learning outcomes tie in with the level and orientation of the programme; they are geared to the expectations of the professional field, the discipline, and international requirements.

Findings

The master's degree programme Offshore & Dredging Engineering (ODE) focuses on the design and operation of all fixed and floating structures in the offshore marine environment for the purpose of:

1. Exploration, exploitation, recovery, storage and transport of valuable materials, like hydrocarbons, minerals and rare metals;

2. Harvesting ocean energy such as offshore wind, offshore solar and offshore biomass farms, wave and tidal energy, OTEC (Offshore Thermal Energy Conversion) and salinity gradient energy;
3. Construction, installation, transportation, maintenance and decommissioning of offshore structures and systems, including auxiliary systems such as autonomously and remotely operated vehicles.
4. Dredging, trenching and deep sea mining of soils, minerals and rare metals.

ODE has a strong interdisciplinary character based on marine, mechanical and civil engineering, with extended use of control engineering, electronics, telematics, logistics and informatics. A thorough knowledge of the physical processes: solid mechanics, fluid mechanics (multi-phase flow), hydromechanics, soil mechanics, drilling and cutting mechanics, is indispensable, according to the programme management, to be able to understand and control the processes involved and to ensure the quality, safety and reliability of ODE systems.

In an appendix of the self-evaluation report, a benchmark is provided with programmes offered at universities in the US, the UK and Australia. These programmes are mainly dedicated to subsea engineering and focused on the oil and gas industry. The ODE programme covers all offshore activities that do not have the purpose of transportation of people or goods. The broad focus on both offshore and dredging makes this programme unique in the panel's opinion.

Developments in Offshore & Dredging Engineering are developing rapidly. In the last decades the scale of Offshore & Dredging systems has increased, while on the other hand the energy transition in the world, and specifically in the Netherlands, is accelerating. The programme management is of the opinion that these developments should be reflected in the master's programme and outlined their thoughts and plans concerning the focus of the master's programme during the site visit. It became apparent that students are strongly involved in the rethinking of the programme, in particular concerning the emphasis on sustainability and renewable energy. The panel appreciates the active attitude of staff and students in adjusting the programme to the developments and requirements of a rapidly changing field.

The Faculty 3mE has an Industrial Advisory Board that meets at least twice a year. Discussions with this Advisory Board showed that the industry needs a broad range of engineers, which is reflected in the intended learning outcomes of the ODE programme. According to the self-evaluation report, ODE engineers need a thorough knowledge of physical processes: solid mechanics, fluid mechanics, hydromechanics, soil mechanics, drilling and cutting mechanics, to be able to understand and control the processes involved and to ensure the quality, safety, and reliability of Offshore and Dredging engineering systems. These requirements are translated in the final qualification 1a: 'apply advanced physics, solid mechanics, fluid mechanics, soil mechanics, hydromechanics and control systems and dynamics to offshore & dredging systems.' (See also Appendix 2.)

The intended learning outcomes are formulated within the framework of the 4TU criteria for academic master's curricula, known as the Meijers criteria[1] (Appendix 2). The panel established that the ILOs are formulated in line with the programme's mission and profile and that they sufficiently indicate what could be expected from programmes at a master's level. It also ascertained that the ILOs meet the internationally accepted description for academic master's programmes, the Dublin descriptors.

TU Delft is the coordinating partner of a double degree programme, the European Wind Energy Master (EWEM), which is offered together with the Technical University of Denmark (DTU), the Norwegian University of Science and Technology (NTNU) and the Carl von Ossietzky Universität Oldenburg Germany (UO). EWEM is an advanced 2-year (120 ECTS) master's degree programme with four specialisations: Wind Physics, Rotor Design, Electric Power Systems and Offshore Engineering. Students receive a double MSc degree from two leading universities in the field of wind

[1] https://www.ram.ewi.utwente.nl/embedded2017/doc/Meijers_summarised.pdf

energy. They do the internship or thesis at one of the partners, spend time at different universities, and experience European student life.

Considerations
The panel established that the ILOs reflect the content, level and orientation of the master's programme ODE and fit the professional field. The current ILOs definitely meet the standard. The panel finds the content of this programme to be of great potential and growing importance. It is a unique programme in the combination of Offshore & Dredging Engineering.

In order to be future-proof and keep track with the rapid developments in the Offshore and Dredging Engineering field, the programme needs continuous tuning. The panel appreciates the strong vision of the programme management in this regard and the involvement of the students in the process of rethinking the profile. In this process the ILOs probably also need revision. The panel encourages the programme to continue evaluating and adjusting the programme and to include, if necessary, the revision of the ILOs in this process.

Conclusion
Master's programme Offshore & Dredging Engineering: the panel assesses Standard 1 as satisfactory.

Standard 2: Teaching-learning environment
The curriculum, the teaching-learning environment and the quality of the teaching staff enable the incoming students to achieve the intended learning outcomes.

Findings
The programme
ODE offers four specialisations: Bottom Founded Structures, Arctic Engineering & Offshore Wind; Dredging Engineering, Trenching, Deep Sea Mining & Subsea Engineering; Floating Offshore Structures; Structural Design & Analysis.

The programme focuses on three connected goals. It aims to teach students the theory of Offshore & Dredging Engineering, to train them to design Offshore & Dredging Systems, and to coach them to perform research on Offshore & Dredging Engineering at an academic level.

The first year of the programme consists of 6 obligatory courses worth a total of 24 EC, a project of 6 EC, specialisation courses of about 15 EC and several electives of about 15 EC. The obligatory courses form a solid basis of the ODE knowledge that all students should master. Two courses are devoted to giving an overview of the ODE domain (*Introduction, Offshore & Dredging*). Four courses are devoted to the fundamentals of ODE (*Hydromechanics, Motions & Loading, Ocean Waves, Probabilistic Design*). One course is devoted to project work (Survey Project or Experimental Exercise). The goal of this project is to teach the students how real oil & gas projects are carried out, including health, safety and environmental issues, and how to design, carry out and interpret experimental research. In the first week of the first year, the programme management organises an introduction week. All specialisations give a presentation in this week. At the end of this week, the students must choose a specialisation. The panel appreciates the solid basis of ODE knowledge provided by the well-chosen obligatory courses.

Most of the second year of the programme is devoted to the graduation project (45 EC). The goal of the second year is to let students work individually on a complex problem, independently using the tools and methods provided, to develop new theory and design methods to solve complex ODE problems. Students must carry out a literature survey of about 15 EC and thesis work on one topic of 30 EC. The panel appreciates that students have the possibility to make a selection of courses for their specialisation track. The varying sizes of the courses (between 2 to 6 EC) makes the planning rather complex, however. The panel advises offering sufficient guidance to the students in this regard.

The programme uses a variety of teaching strategies:

- Lectures, possibly combined with homework assignments.
- Research: there is a lot of research available in the labs (usually participating in PhD projects).
- Projects: students must work in teams on hands-on problems in ODE.
- Self-study: unsupervised learning activities.
- Literature survey: making an extensive search in the available literature of a certain topic and writing a coherent and critical report of the findings.
- Thesis work: digging deep into a challenging problem, typically related to a scientific or societal need, and developing a new theoretical approach or a new design method to solve the problem.

At TU Delft, it is possible to do a double degree. TU Delft is in fact, as described under standard 1, coordinating the double degree programme European Wind Energy Master. An increasing number of students is making use of the option to do a double degree (about 15 so far), indicating that there is a demand. In a double degree, the student must do two times 60 EC on non-overlapping courses in two different programmes and 60 EC in a joint graduation project. As ODE is a multidisciplinary field, it is a popular programme to combine with other master's programmes. The panel appreciates the interdisciplinary character of the ODE programme and agrees with the programme management that this interdisciplinarity provides an attractive opportunity for students to do this programme next to a disciplinary master's programme in a double degree.

Students and study yield

The self-evaluation report describes an increase in the intake of students until 2014 and a sharp decline in intake since then (from 170 in 2014 to 47 in 2017). This decline is attributed to the very low oil price in the last few years, resulting in fewer investments in industry and becoming less attractive to students because of the energy transition. In the current academic year the intake has increased again. Currently, 300 students are registered in the ODE master's programme. The percentage of female students fluctuates between 7 and 18%, and the percentage of international students from 20 to 39%. The majority of the students come from outside TU Delft. The panel appreciates that the programme manages to make all the students feel integrated.

The success rate of the master's students within 3 years is 70% on average, the average study time is 2.6 years. The self-evaluation indicates that the career prospects for graduates is very good. Many graduates already have a job when they finish their programme, others find a job within a few months.

Teaching Staff

The staff in the ODE programme has a background in Mechanical Engineering, Marine Technology or Civil Engineering. All staff members conduct research and are actively contributing to the development of their disciplines. 59% holds a UTQ, which is very low compared to the percentage in other programmes of TU Delft; the panel recommends encouraging all teachers to get a UTQ certification. 26% of the staff is from outside the Netherlands. The panel did not get an indication of the number of female staff members. The students are satisfied with the teaching quality. The panel was surprised that the percentage of UTQ holders in the ODE staff is relatively low despite the Faculty commitment to developing and maintaining the quality of teaching staff.
Total number of teaching staff involved in the programme is 19.2 fte, according to the information in the self-evaluation report, indicating a student-staff ratio of 15:1.

Facilities

The ODE programme has its own wing in the 3mE building. The ODE laboratory is situated close to this wing, and consists of a slurry transport test loop and some tanks for high-density, two-phase slurry flow and physics at the interface of solid and fluid mechanics. There are also facilities for the ODE programme in the CiTG building. These labs are used by students for their practicals. The

facilities for the programme look very good to the panel, but the students mentioned that they would like to see more use of them in the teaching activities.

Considerations
The curriculum of the master's programme Offshore & Dredging Engineering enables the students to achieve the intended learning outcomes. The panel appreciates the highly interdisciplinary character of the programme and the solid basis of ODE knowledge provided by the well-chosen obligatory courses.

The quantity and quality of the teaching staff meet the standard, but the panel recommends encouraging all teaching staff members to get a UTQ certification. The policy of the Faculty 3mE regarding developing and maintaining the teaching quality is very much appreciated. The panel is also very positive about the active attitude of the teachers towards developing and improving the programme in order to adjust it to developments in the field.

The lab and study facilities of the programme are good.

Conclusion
Master's programme Offshore & Dredging Engineering: the panel assesses Standard 2 as satisfactory.

Standard 3: Student assessment
The programme has an adequate system of student assessment in place.

Findings
Assessment policy
The Faculty aims to achieve a high level of quality in its teaching and assessment. The aim is to achieve the highest possible quality standards in relation to validity, reliability and transparency for assessments, within the limits of feasibility. The Faculty's complete vision and policy on assessment is described in the document 'Toetsing bij 3mE'. In order to determine adequately whether a student has achieved the final qualifications, every form of assessment is tailored to the learning objectives and teaching formats (constructive alignment). An examiner should have or be in the process of obtaining the UTQ certificate. All examiners in the master's programme are employed by TU Delft.

In the process of constructing tests, examiners have to apply the 'four-eyes' principle with a colleague in the interests of safeguarding the quality of assessment. This can vary from the provision of feedback to doing trial tests, discussing the answering model and jointly determining the pass mark. Examiners have to make a test matrix in advance as a blueprint for their exams to guarantee the constructive alignment.

Once every three years, the educational advisor provides the examiners with feedback on test issues such as reliability, validity, construction and safeguarding of the learning objectives. Examiners are expected to keep working on improving quality and using the relevant instruments. The educational advisor is always available for support at the examiner's request. At the end of every semester, the educational advisor submits an evaluation with findings and recommendations to the Board of Examiners and the Director of Education.

For written exams, students receive their grades within 15 working days after the exam date. Students have the right to feedback on their exam work within 20 working days after the grade publication date. Most lecturers organise offices hours or something similar for students to check their exams and ask questions. Students increasingly receive digital scans of the exams they have taken and handle the feedback procedure online as well.

During the site visit the panel learned about the test matrix that is used to align the programme-wide intended learning outcomes, the learning outcomes of the course, the course exam and the

assessment. The panel found this matrix to be very helpful and a good instrument to improve the validity and the quality of assessments. It is also very positive about the assessment policy in general and approves the position of the educational advisor and the support given by the educational advisor to the teaching staff to improve the assessment quality.

Assessment methods
In the ODE programme several methods of formative and summative testing are used: written exams, oral exams, individual project work, group project work, and homework assignments.

The graduation project is split into two parts: a literature survey and a thesis project. The student writes a report about the literature survey, which is graded separately and provides an indication of the final grade for the thesis project. The thesis is assessed by a graduation committee, which consists of at least two scientific staff members and one postdoc or PhD. One staff member should be from another section or preferably department. The chair must be a full professor or an associate professor who is authorised by the Board of Examiners to sign the master certificate. The thesis is assessed with a uniform master's thesis grading rubric.

Board of Examiners
The Board of Examiners (BoE) of 3mE consists of a chairman, a secretary, one member of each research department and an external member from another Faculty. The BoE performs its duties independently. The chairman and the secretary of the BoE hold regular meetings with the Dean, the Director of Education, and other TU Delft Boards of Examiners to discuss common concerns and improve assessments.

The BoE monitors the quality of assessment and the correct application of the Teaching and Examination Regulations. Additionally, it deals with students with special personal circumstances and with appeal cases. It has regular meetings in which it decides on cases brought in by students and staff members. The outcomes of the decisions are communicated in writing. In order to promote the equal treatment of students and to preserve the ability to act decisively, wherever possible decisions are transformed into policy and recorded in internal policy documents.

The BoE has set strict rules for the composition of graduation committees and for graduating with distinction. It has a fraud and a complaints committee, each consisting of three members. These committees advise the BoE, which comes to a joint decision. There is a protocol for the procedure to be followed in cases of fraud. The BoE maintains close contact with the educational advisor about the quality of the exams. The semester evaluation by the educational advisor is regularly discussed in a meeting of the BoE. In specific cases, the BoE can request the educational advisor to provide feedback or an analysis of an exam that was not assessed that year.
Every year, the BoE writes an annual report on the performance of its statutory duties.

The BoE inspects the thesis work and accompanying assessment forms twice a year for a number of randomly chosen master students and assesses whether the graduation committees made fair judgements leading to the final grades.

According to the panel the BoE has put adequate procedures in place to check the quality of assessment in the programme. The panel is very positive about the way the BoE is performing its tasks.

Considerations
The Faculty's assessment system and policy are well developed and implemented. All teachers are aware of the policies and measures implemented to assure the validity and reliability of the assessments. The Faculty has ensured that the teachers are supported in their tasks by the appointment of an educational advisor.

The courses in the master's programme use a variety of assessment methods, which are very well aligned, with the help of the matrices, with the learning outcomes and the curriculum. The assessment procedure for the master's thesis is well developed, documented and transparent.

The panel is very positive about the way the Board of Examiners is performing its tasks and concluded that the examinations, tests and thesis assessment are transparent, valid and reliable.

Conclusion
Master's programme Offshore & Dredging Engineering: the panel assesses Standard 3 as good.

Standard 4: Achieved learning outcomes
The programme demonstrates that the intended learning outcomes are achieved.

Findings
The panel studied a selection of 15 master's theses to assess whether the graduates achieved the intended learning outcomes. It concluded that the master's graduates did indeed achieve the level that can be expected of them. It studied a selection of theses with a mix of high grades and low grades and found them to be of a high level overall. The theses showed that the graduates are able to conduct research and design independently, have a scientific approach to complex problems and ideas and the ability to seek new potential applications, taking the social context into consideration. The theses showed an advanced level of knowledge in a specialised field, systematic understanding of the key aspects and concepts in Offshore and Dredging Engineering, and the ability to integrate theory and practice.

As mentioned under standard 2, graduates easily find a job. The Faculty has an active Industrial Advisory Board, including Offshore & Dredging Engineering members. This board meets twice a year and is involved in curriculum changes, research reviews and the profile of the graduates. A recent survey of employers showed that the professional field perceives the graduates as competent. This was confirmed by the alumni in a national survey in 2017.

Considerations
The panel concludes that graduates of the master's programme Offshore & Dredging Engineering have achieved the intended learning outcomes. It found the level of the master theses to be good. The graduates are well prepared for continuing in a PhD programme or a career in industry.

Conclusion
Master's programme Offshore & Dredging Engineering: the panel assesses Standard 4 as good.

GENERAL CONCLUSION

The panel assesses standards 3 and 4 of the master's programme as good and standards 1 and 2 as satisfactory. It was positive about the assessment system and the level achieved by the master's graduates. Following the NVAO decision rules, the panel's general conclusion is that the programme is assessed as good.

Conclusion
The panel assesses the *master's programme Offshore & Dredging Engineering* as good.

APPENDICES

APPENDIX 1: DOMAIN-SPECIFIC FRAMEWORK OF REFERENCE

On a global scale, to ease the scarcity of land, hydrocarbons, minerals and rare metals and to reduce the impact on the environment and on society, the reclamation of land for industrial purposes and the exploration of hydrocarbons and minerals is moving more and more offshore into deeper waters. To open new horizons and to meet the challenges of the near future requires the development of new, innovative, inter-disciplinary technologies and methodologies. The exploration of hydrocarbons at 3000m water depth, floating airports, trailing suction hopper dredges of 50.000m3, diamond mining at the sea and ocean floor with remote/autonomous operated vehicles, pipe-laying in deep water, arctic engineering, deep-sea mining and offshore renewable energy (Ocean Energy) will all be possible in the near future but requires a lot of applied and fundamental research.

ODE focuses on the design and operation of all fixed and floating structures in the offshore marine environment aimed at:
1. Exploration, exploitation, recovery, storage and transport of valuable materials, like hydrocarbons, minerals and rare metals;
2. Harvesting ocean energy, such as offshore wind, offshore solar and offshore biomass farms, wave and tidal energy, OTEC (Offshore Thermal Energy Conversion) and salinity gradient energy;
3. Construction, installation, transportation, maintenance and decommissioning of offshore structures and systems, including auxiliary systems such as autonomous and remote operated vehicles;
4. Dredging, Trenching & Deep Sea Mining of soils, minerals and rare metals;

Offshore and Dredging Engineering has a strong inter-disciplinary character based on marine, mechanical and civil engineering, with extended use of control engineering, electronics, telematics, logistics and informatics. Offshore and Dredging Engineering systems are characterized by large scale, capital intensive, unique systems, with possibly a connection to the sea-floor, subjected to an aggressive environment with wind, wave and current induced high static and dynamic forces, that influence the behaviour and operations. During the last decades the scale of Offshore and Dredging Engineering systems has increased (due to societal and economic demands) and is expected to further increase, with respect to dimensions, operating water depth, transport distance, production and thus investment. At the same time, the demand for higher quality, accuracy, safety, reliability and sustainability is also increasing, requiring a high level of process knowledge and control. The integrated use of modern technologies with respect to the design and operations stages such as solid modelling, Finite Element Method (FEM), Discrete Element Method (DEM), multi-body dynamics, ship hydrodynamics, Computational Fluid Dynamics (CFD) and control engineering (simulation) software for the design stage and dynamic positioning, tracking and monitoring systems for the operations stage, requires an inter-disciplinary approach, similar to Mechatronics, but on a large scale: Megatronics.

Offshore and Dredging Engineering can be subdivided into the following phases:
- Exploration, investigation
- Planning and design
- Fabrication, construction
- Transportation, installation
- Operations: exploitation, excavation and mining
- Monitoring, inspection and maintenance
- Decommissioning

The physical processes involved can be subdivided into to following categories:
- Drilling, mining and cutting processes, ice mechanics
- Reaction forces counteracting the drilling, mining and cutting forces (Mooring systems)
- Vertical transport
- Pre-processing and buffering
- Horizontal (hydraulic) transport, discharge and sedimentation

- Dispersed multi-phase flows
- The response of Offshore and Dredging systems to the aggressive offshore environment
- Ocean energy, wind, waves, current, temperature gradient, salinity, biomass, etc.

A thorough knowledge of the physical processes; solid mechanics, fluid mechanics (multi-phase flow), hydromechanics, soil mechanics, drilling and cutting mechanics is indispensable to be able to understand and control the processes involved and to ensure the quality, safety and reliability of Offshore and Dredging engineering systems. Ocean Energy requires cooperation with new fields which is currently studied.

APPENDIX 2: INTENDED LEARNING OUTCOMES

1. Competent in the scientific discipline Offshore & Dredging Engineering

A graduate in Offshore & Dredging Engineering is able to...

1A. ...apply advanced physics, solid mechanics, fluid mechanics, soil mechanics, hydromechanics and control systems and dynamics on offshore & dredging systems.
1B. ...apply measurement methods and design, carry out and evaluate experiments to validate physical models.
1C. ...design, identify and control offshore & dredging systems in relation with operations and the environment.
1D. ...relate scientific knowledge to offshore & dredging systems considering their interaction with the environment..

2. Competence in conducting research

A graduate in Offshore & Dredging Engineering is able to...

2A. ...study a topic by critically selecting relevant scientific literature and critically evaluating the content.
2B. ...write a scientific report about own research or relevant scientific literature.
2C. ...analyse Offshore & Dredging Engineering systems at various levels of abstraction, including a reflective understanding of their structure and relations to other fields.
2D. ...develop technologies to model, identify and control Offshore & Dredging systems.
2E. ...generate knowledge within the discipline of Offshore & Dredging Engineering.

3. Competence in designing

A graduate in Offshore & Dredging Engineering is able to...

3A. ...systematically design complex Offshore & Dredging systems, including installation, operations and decommissioning.
3B. ... generate innovative contributions to the discipline of Offshore & Dredging systems.

4. A scientific approach

A graduate in Offshore & Dredging Engineering is able to... :

4A. ...apply paradigms, methods and tools to design an Offshore & Dredging Engineering system.
4B. ...analyse problems and use modelling, simulation, design and integration towards solutions.
4C. ...manage own scientific research independently, in a consistent and structured way and with a critical attitude.

5. Basic intellectual skills

A graduate in Offshore & Dredging Engineering is able to...

5A. ...analyse and solve technological problems in a systematic way.
5B. ...plan and execute research and design in changing circumstances.
5C. ...integrate knowledge in an R&D project, considering ambiguity, incompleteness and limitations.
5D. ...identify and acquire lacking expertise.
5E. ...critically reflect on own knowledge, skills and attitude.
5F. ...remain professionally competent.
5G. ...take a standpoint with regard to a scientific argument within the research area.

6. Competent in operating and communicating

A graduate in Offshore & Dredging Engineering is able to...

6A. ...work both independently and in multidisciplinary teams.
6B. ...present and report in good English.
6C. ...explain and defend outcomes from the research area to academia and industry, to specialists and laymen.

7. Considering the temporal and social context

A graduate in Offshore & Dredging Engineering is able to...

7A. ...evaluate and assess the technological, ethical and societal impact of own work.
7B. ...act responsibly with regard to sustainability, economy and social welfare.

APPENDIX 3: OVERVIEW OF THE CURRICULUM

MASTER OFFSHORE AND DREDGING ENGINEERING - 2018-2019		
COURSE CODE	COURSE NAME	ECTS
MASTER YEAR 1		
Obligatory Courses ODE		
CIE4130	Probabilistic Design	4
MT44085	Buckling & Ultimate Strength in Marine Structures	5
CIE4325	Ocean Waves	6
MT44020	Motions & Loading of Structures in Waves	5
MT44045	Introduction to Ship and Offshore Hydromechanics	3
OE44005	Introduction to Offshore Engineering	3
OE44010	Introduction to Dredging Engineering	3
OE44145	Research Exercise	6
OE44015	Offshore & Dredging Engineering Project	6
ODE Bottom Founded Offshore Structures, Arctic & Wind		
CIE4140	Structural Dynamics	4
OE44096	Bottom Founded Offshore Structures	6
OE44096 T1	Assignment	2
OE44096 T2	Exam	4
OE44100	Floating Structures & Offshore Moorings	6
ODE Dredging Engineering		
OE44030	Offshore Geotechnical Engineering	4
OE44035	Dredging Pumps & Slurry Transport	4
OE44040	Dredging Processes I	4
OE44045	Dredging Processes II	3
OE44050	CFD for Dredging and Offshore Engineering	3
ODE Floating Offshore Structures		
CIE4140	Structural Dynamics	4
OE44100	Floating Structures & Offshore Moorings	6
OE44125	Dynamic Positioning	3
ODE Structural Analysis & Design		
CIE4140	Structural Dynamics	4
MT44030	Structural Design and Analysis	5
OE44085	Fatigue & Fracture in Marine Structures	5
ODE Keuzevakken		
OE44000	Attending Student Colloquia	1
MS43805	Material en Fabrication Factors in Marine Structures	5
OE44030	Offshore Geotechnical Engineering	4
OE44055	Load identification and monitoring of structures	4
OE44075	Ocean Energy Technologies	4
OE44105	Marine Pipelines	4
OE44110	Subsea Engineering	4
OE44115	Arctic Engineering	4
OE44120	Offshore Wind Farms Design	4
OE44135	Offshore Wind Support Structures	4
OE44091	Structural Dynamics Practical	2
ODE Free Specialisation (to be filled in consultation with mastercoordinator)		
MASTER YEAR 2		
Obligatory Courses ODE		
OE54015	Problem Analysis Thesis	15
OE54030	Thesis	30
ODE Keuzevakken		
AT327-12	Arctic Offshore Engineering (Spitsbergen)	6
OE44025	Drive system design principles	3
OE44090	Introduction to Computational Dynamics of Offshore Structures	4
OE44140	Multidisciplinary Project	1-15
OE54000	Industrial Practice	15

APPENDIX 4: PROGRAMME OF THE SITE VISIT

Thursday 13 December 2018

Time	Activity	Function
08.30–08.45 h	Welcome	Director of Education 3mE
08.45–09.45 h	Programme Management	Dean 3mE Director of Education 3mE Director of Studies Master's coordinator Master's coordinator Head Education & Student Affairs
09.45 – 10.00 h	*Break*	
10.00–10.45 h	Bachelor Students Mechanical Engineering	
10.45–11.00 h	*Break*	
11.00–11.45 h	Master's Students Mechanical Engineering & Materials Science & Engineering	
11.45–12.15 h	*Lunch*	
12.15–12.45 h	Roundtour	
12.45–13.30 h	Staff Mechanical Engineering	
13.30-13.45 h	*Break*	
13.45–14.30 h	Staff Materials Science & Engineering	
14.30–14.45 h	*Break*	
14.45–15.15 h	Board of Examiners	Chair Member Member Secretary Educational Advisor
15.15–15.30 h	*Break*	
15.30–16.30 h	Professional Field Alumni	Boskalis (ME) Huisman Equipment (MSE) De Voogt Nav.Arch. (ODE) Alumnus ME Alumnus ME Alumnus MT
16.30–18.00 h	*Drafting preliminary conclusions*	

Friday 14 December 2018

Time	Activity	Function
08.30 – 08.45 h	Arrival	
08.45–09.45 h	Programme Management Marine Technology & Offshore and Dredging	Dean 3mE Director of Education Director of Studies Director of Studies Master's coordinator Head Education & Student Affairs
09.45–10.00 h	*Break*	
10.00–10.45 h	Students Marine Technology	
10.45–11.00 h	*Break*	
11.00–11.45 h	Staff Marine Technology & Offshore and Dredging Engineering	
11.45–12.30 h	*Lunch*	
12.30–13.00 h	Students Offshore & Dredging Engineering	
13.00–13.45 h	Programme Management Representatives	Dean 3mE Director of Education Director of Studies Director of Studies Head Education & Student Affairs
13.45–16.00 h	*Drafting preliminary conclusions*	
16.00–17.15 h	Feedback meeting & drinks	

APPENDIX 5: THESES AND DOCUMENTS STUDIED BY THE PANEL

Prior to the site visit, the panel studied 15 theses of the master's programme Offshore & Dredging Engineering. Information on the selected theses is available from QANU upon request.

During the site visit, the panel studied, among other things, the following documents (partly as hard copies, partly via the institute's electronic learning environment):

- 3mE Vision on Education
- Criteria for Academic Bachelor's and Master's Curricula
- Film Lab Facilities
- Toetsing bij 3mE
- Teaching and Examination Regulations Mechanical Engineering 2018-2019
- Masters 3mE Graduation Procedure
- Results of Employers Survey
- Year report Master degree programme Offshore & Dredging Engineering 2016-2017
- 3mE Annual Report, MSc Mechanical Engineering 2016-2017
- Minutes Board of Examiners 2017-2018
- Minutes Board of Studies 2017-2018