Werktuigbouwkunde
3TU WO 2012

Department of Mechanical Engineering,
Eindhoven University of Technology

Quality Assurance Netherlands Universities (QANU)
Catharijnesingel 56
PO Box 8035
3503 RA Utrecht
The Netherlands

Phone: +31 (0) 30 230 3100
Telefax: +31 (0) 30 230 3129
E-mail: info@qanu.nl
Internet: www.qanu.nl

Project number: Q286

CONTENTS

This report was finalised on 23 November 2012.

Report on the bachelor's programme Mechanical Engineering and the master's programme Mechanical Engineering of Eindhoven University of Technology

This report takes the NVAO's Assessment framework for limited programme assessments as a starting point.

Administrative data regarding the programmes

Bachelor's programme Mechanical Engineering

Name of the programme:	Mechanical Engineering
CROHO number:	56966
Level of the programme:	bachelor's
Orientation of the programme:	academic
Number of credits:	180 EC
Specialisations or tracks:	-
Location(s):	Eindhoven
Mode(s) of study:	full time
Expiration of accreditation:	31-12-2013

Master's programme Mechanical Engineering

Name of the programme:	Mechanical Engineering
CROHO number:	60439
Level of the programme:	master's
Orientation of the programme:	academic
Number of credits:	120 EC
Specialisations or tracks:	Computational and experimental mechanics; Dynamical systems design; Thermo fluids engineering
Location(s):	Eindhoven
Mode(s) of study:	full time
Expiration of accreditation:	31-12-2013

The visit of the assessment committee Werktuigbouwkunde 3TU WO 2012 to the Department of Mechanical Engineering of Eindhoven University of Technology took place on 25 September 2012.

Administrative data regarding the institution

Name of the institution:	Eindhoven University of Technology
Status of the institution:	publicly funded institution
Result institutional quality assurance assessment:	applied (pending)

Quantitative data regarding the programmes

The required quantitative data regarding the programmes are included in Appendix 5.

Composition of the assessment committee

The committee that assessed the bachelor's programme Mechanical Engineering and the master's programme Mechanical Engineering consisted of:

- Prof. dr. J.K.M. de Schutter, professor of Mechanical Engineering, KU Leuven;
- Prof. dr. J.J. ter Meulen, emeritus professor Applied Physics, Radboud University Nijmegen;
- Ir. G. Calis, former Corporate Head Office Stork B.V.;
- Ir. H. Grunefeld, educational development consultant, Utrecht University;
- T.O.W. Opraus, bachelor student of Mechanical Engineering, Delft University of Technology.

The committee was supported by Dr. M.J.H. van der Weiden, who acted as secretary.

Appendix 1 contains the curricula vitae of the members of the committee.

Working method of the assessment committee

Preparation
The assessment of the bachelor's programme Mechanical Engineering and the master's programme Mechanical Engineering of Eindhoven University of Technology is part of a cluster assessment of ten Mechanical engineering degree programmes offered by three universities. The entire cluster committee consists of nine members. The kick off meeting for the cluster assessment was held on 4 September 2012. During this meeting the committee members received an introduction into the assessment framework and evaluation procedures and the committee agreed upon its general working method. For each visit a subcommittee was composed with the necessary expertise to evaluate the programme. Furthermore, the domain-specific requirements and the most recent developments concerning the mechanical engineering domain were discussed. These domain-specific requirements and the actual context form the starting point for the evaluation of the quality of the degree programmes.

In advance of the assessment of the programme the programme management prepared a self-evaluation report. This report was sent to QANU and, after a check by the secretary of the committee to ensure that the information provided was complete, forwarded to the committee members. The committee prepared the site visit by studying the self-evaluation report and a number of bachelor and master theses. The secretary of the committee selected theses randomly from a list of all graduates of the last two years per programme, i.e. fifteen master theses and fifteen reports of the final bachelor project. The following stratification is used: five theses for each degree programme with low grades (6-6.5), five theses with middle ranged grades (7-8) and five theses with high grades. QANU asked the programmes to send in the theses including the assessment by the supervisor and other examiners, and divided them among the subcommittee members. Each committee member thus assessed three theses per programme.

When a thesis was assessed as questionable or unsatisfactory by a committee member, a reassessment was done by another committee member. In the case that more than 10% of the theses were assessed as questionable or unsatisfactory by two committee members the selection of theses for the programme would be extended to 25. This was not the case.

Site visit
The committee members formulated questions raised by studying the self-evaluation report in advance. These questions were circulated in the committee.

The committee visited the programmes on 25 September 2012. The programme of the site visit, which is included in Appendix 6, was developed by the committee's secretary in consultation with the programme management and the chair of the committee. The committee interviewed students, teachers, alumni, the programme management and representatives of the Faculty Board, the Board of Examiners and the student and teacher members of the Education Committee. An open office hour was scheduled and announced but no one made use of it.

Before and during the site visit the committee studied additional material made available by the programme management. Appendix 7 gives a complete overview of all documents available during the site visit. The last hours of the site visit were used by the committee to establish the assessments of the programme and to prepare the oral presentation of the preliminary findings of the committee to the representatives of the programme.

Report
The secretary wrote a draft report based on the findings of the committee. The draft report has been amended and detailed by the committee members. After approval of the draft report by the committee it was sent to the Department for a check on facts. The comments by the Department were discussed in the committee, which resulted in some changes in the report, and, subsequently, the committee established the final report.

The assessment was performed according to the NVAO (Accreditation Organisation of the Netherlands and Flanders) framework for limited programme assessment (as of 22 November 2011). In this framework a four-point scale is prescribed for both the general assessment and assessment of each of the three standards. The committee used the following definitions for the assessment of both the standards and the programme as a whole.

Decision rules

Generic quality
The quality that can reasonably be expected in an international perspective from a higher education bachelor's or master's programme.

Unsatisfactory
The programme does not meet the current generic quality standards and shows serious shortcomings in several areas.

Satisfactory
The programme meets the current generic quality standards and shows an acceptable level across its entire spectrum.

Good
The programme systematically surpasses the current generic quality standards across its entire spectrum.

Excellent
The programme systematically well surpasses the current generic quality standards across its entire spectrum and is regarded as an (inter)national example.

Summary judgement

Bachelor programme Mechanical Engineering

This report presents the findings and considerations of the Werktuigbouwkunde 3TU committee on the bachelor's programme Mechanical Engineering at Eindhoven University of Technology. The committee bases its assessment on information from the self-evaluation report, additional information obtained from the discussions during the visit, the selected theses, and the documentation that was available for inspection during the site visit. For this programme, the committee has identified positive aspects as well as ones that could be improved. After considering them, the committee reached the conclusion that the programme meets the requirements for basic quality that form the condition for re-accreditation.

Standard 1: Intended learning outcomes

The intended learning outcomes of the bachelor programmes are based on the internationally accepted ABET standards. In addition, the 3TU have added criteria to this domain-specific frame of reference to emphasise future developments in science and society.

The final qualifications require that bachelor graduates have a disciplinary foundation in science, engineering and technology, are aware of the importance of other disciplines and of the temporal and social context, are able to investigate and design under supervision, have learned a scientific approach and have developed intellectual and communicative skills.

The learning objectives have been formulated in terms of academic competences, an outcome of the Academic Competences and Quality Assurance (ACQA) project. In an annex to the self-evaluation report the programme has provided an overview of the intended learning outcomes, the ACQA-competences and the Dublin descriptors. This shows that the final qualifications for the bachelor programme are in line with the international standards as described in the Dublin descriptors.

The committee concludes that the bachelor programme in Mechanical Engineering is clearly designed as an academic programme. It provides a solid disciplinary foundation and has a strong focus on research and on developing a scientific and critical attitude.

Standard 2: Teaching and learning environment

The new bachelor programme, starting 2012-2013, consists of basic courses in mathematics, physics, design, modelling and USE (User, Society and Enterprise), disciplinary courses in mechanical engineering and Design Based Learning (DBL) projects. In the projects students learn in groups of 8-10 students to apply the theoretical concepts to practical engineering problems and, also, to develop social and professional skills. In the second and third year students can select a number of elective courses. The bachelor final project (BFP) is a substantive individual project. Students have to show initiative and analytical skills and must present their results in a written report and an oral presentation. The report must meet academic standards.

The curriculum described above is a re-designed and modular programme. In 2012-2013 the second and third year of the bachelor programme are of the 'old' programme. They have a different set-up (more but smaller courses and fewer elective courses) but the main mechanical engineering content and approach are the same. The bachelor curriculum is coherent and has a good scientific profile. It presents the students with an increasing degree of complexity.

The bachelor programme has an appropriate mix of lectures, guided self-study, group work in the DBL projects and individual work in courses (exam preparation) and the BFP. Students are positive about the learning outcomes of the DBL projects. The projects provide a good link between theory and practice and students acquire academic and professional skills.

The committee finds the feasibility of the programme to be realistic even though very few students finish in the nominal time. The structure of the programme allows students who want to obtain their degree within the allotted time to do so. Students are required to at least obtain 30 EC in the first year before they are allowed to continue (Binding Study Advice, BSA). The committee understands that the 30 EC limit has been established by the Board of the University, but finds this limit not very ambitious. Per September 2012 the university has introduced the 'harde knip', the requirement to have finished the bachelor programme before starting the master programme. The department has developed a good set of regulations to do justice to the 'harde knip' without creating a long study delay for students who are only a few credits short.

The teaching staff of Mechanical Engineering is well-qualified and committed. More staff members should be stimulated to acquire the University Teaching Qualification, for instance by organising meetings based on best practices and an exchange of experiences. Contacts between lecturers and students are frequent and informal. Students express their appreciation of this. The teaching load is high, especially because of the process of re-design of the bachelor programme. The student interest is not evenly distributed over the research groups and professors. Students, therefore, cannot always do the BFP of their first choice. For the bachelor programme the committee finds this acceptable.

The department has ample facilities in a newly renovated building. The study guidance and counselling are very well organised and students appreciate the proactive approach of the student counsellors.

The quality assurance system is firmly embedded in a PDCA-cycle. All courses are regularly evaluated by student questionnaires and the results are discussed by the quality control officer with the lecturers and the Education Committee. The committee advises to investigate how the response rates can be increased because they are often quite low. The department has followed up on the recommendations of the previous assessment committee.

Standard 3: Assessment and achieved learning outcomes
Bachelor courses are assessed by written exams. Exams are cross-checked and verified by colleague lecturers prior to the exam date. The assessment of the DBL projects is a combination of an assessment of the group report and of the individual contribution to the group work. After a training in peer review students assess each other. They express their satisfaction with this procedure. The BFP is assessed on the basis of an academic report and a presentation.

The committee recommends that for each course and each project clear descriptions of the learning objectives are provided, including a test matrix. This will guarantee the transparency, validity and reliability of the assessments. The committee also advises the Board of Examiners to check the implementation of the assessment procedures, especially of the BFP.

The committee examined a representative sample of bachelor theses and generally found the marking to be fair and consistent. On the basis of the theses, the committee concludes that graduates achieve an academic bachelor's level.

This conclusion is confirmed by the experiences recounted by the alumni. Graduates find relevant jobs at an appropriate level within a fairly short time, and they are satisfied with the broad knowledge basis and engineering skills they learned in the programme. They would have wished more systematic attention to soft skills and professional skills. The new bachelor programme is expected to address this aspect.

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

Bachelor's programme Mechanical Engineering:

Standard 1: Intended learning outcomes	good
Standard 2: Teaching-learning environment	satisfactory
Standard 3: Assessment and achieved learning outcomes	satisfactory
General conclusion	satisfactory

Master programme Mechanical Engineering

This report presents the findings and considerations of the Werktuigbouwkunde 3TU committee on the master's programme Mechanical Engineering at Eindhoven University of Technology. The committee bases its assessment on information from the self-evaluation report, additional information obtained from the discussions during the visit, the selected theses, and the documentation that was available for inspection during the site visit. For this programme, the committee has identified positive aspects as well as ones that could be improved. After considering them, the committee reached the conclusion that the programme meets the requirements for basic quality that form the condition for re-accreditation.

Standard 1: Intended learning outcomes

The intended learning outcomes of the master programme are based on the internationally accepted ABET standards. In addition, the 3TU have added criteria to this domain-specific frame of reference to emphasise future developments in science and society.

Master graduates have taken the bachelor qualifications a step further and are able to design and conduct research independently, on the basis of extended (inter)disciplinary knowledge and skills. They are science-oriented designers and design-oriented researchers.

The learning objectives have been formulated in terms of academic competences, an outcome of the Academic Competences and Quality Assurance (ACQA) project. In an annex to the self-evaluation report the programme has provided an overview of the intended learning outcomes, the ACQA-competences and the Dublin descriptors. This shows that the final qualifications for the master programme are in line with the international standards as described in the Dublin descriptors.

The committee concludes that the master programme in Mechanical Engineering is clearly designed as an academic programme. It provides a solid disciplinary foundation and has a strong focus on research and on developing a scientific and critical attitude.

Standard 2: Teaching and learning environment

The master programme is an individualised programme. At the start of the master phase a student chooses a study track, related to one of the department's research programmes, and a graduation professor. The student puts together a programme and presents this to a professor for approval. The programme consists of elective courses and an internship in the first year, and individual study space and a graduation project in the final year. Many students find an internship abroad. The coherence of the programme is safeguarded by the rules set by the Board of Examiners.

The committee finds the feasibility of the programme to be realistic even though very few students finish in the nominal time. The structure of the programme allows students who want to obtain their degree within the allotted time to do so. For the long duration of the master programme the main effect is to be expected from a culture change: students should be aware that 'good' is 'good enough' and that meeting deadlines is a fact of life in a professional career too. Staff should try to fit their expectations of graduation theses to the 45 EC allotted to them. The committee advises to monitor the time invested by students in their graduation thesis on a regular basis.

The teaching staff of Mechanical Engineering is well-qualified and committed. More staff members should be stimulated to acquire the University Teaching Qualification, for instance by organising meetings based on best practices and an exchange of experiences. Contacts between lecturers and students are frequent and informal. Students express their appreciation of this. The teaching load is high, especially because of the re-design of the bachelor programme. The student interest is not evenly distributed over the research groups and professors. The committee is of the opinion that students should always be allowed to do the master graduation project of their first choice. So far, it seems creative solutions have been found, calling upon the input of PhD students.

The department has ample facilities in a newly renovated building. The study guidance and counselling are very well organised and students appreciate the proactive approach of the student counsellors.

The quality assurance system is firmly embedded in a PDCA-cycle. All courses are regularly evaluated by student questionnaires and the results are discussed by the quality control officer with the lecturers and the Education Committee. The committee advises to investigate how the response rates can be increased because they are often quite low. The department has followed up on the recommendations of the previous assessment committee.

Standard 3: Assessment and achieved learning outcomes

Master courses are assessed by a written or oral exam, sometimes based on an assignment. The internship is assessed on the basis of a written report and a presentation. For the assessment of the graduation project a graduation committee of three members is composed, one of which is a staff member of another research group or an external member.

The committee recommends that for each course and each project clear descriptions of the learning objectives are provided, including a test matrix. This will guarantee the transparency, validity and reliability of the assessments. The committee also advises the Board of Examiners to check the implementation of the assessment procedures.

The committee examined a representative sample of master theses and generally found the marking to be fair and consistent. The large number of scientific articles that are based on master theses is a strong point. It expresses the academic quality of the master programme. On the basis of the theses, the committee concludes that graduates achieve an academic master's level.

This conclusion is confirmed by the experiences recounted by the alumni. Graduates find relevant jobs at an appropriate level within a fairly short time, and they are satisfied with the broad knowledge basis and engineering skills they learned in the programme. They would have wished more systematic attention to soft skills and professional skills. The new bachelor programme and, subsequently, the new master programme are expected to address this aspect.

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

Master's programme Mechanical Engineering:

Standard 1: Intended learning outcomes	good
Standard 2: Teaching-learning environment	satisfactory
Standard 3: Assessment and achieved learning outcomes	good
General conclusion	good

The chair and the secretary of the committee hereby declare that all members of the committee have studied this report and that they agree with the judgements laid down in the report. They confirm that the assessment has been conducted in accordance with the requirements relating to independence.

Date: 23 November 2012

Prof. dr. J.K.M. de Schutter

Dr. M.J.H. van der Weiden

Description of the standards from the Assessment framework for limited programme assessments

Standard 1: Intended learning outcomes
The intended learning outcomes of the programme have been concretised with regard to content, level and orientation; they meet international requirements.

Explanation:
As for level and orientation (bachelor's or master's; professional or academic), the intended learning outcomes fit into the Dutch qualifications framework. In addition, they tie in with the international perspective of the requirements currently set by the professional field and the discipline with regard to the contents of the programme.

1.1. Findings
This section contains the committee's assessment on the profile and orientation of the programme (1.1.1), the domain-specific framework of reference (1.1.2) and the intended learning outcomes (1.1.3).

1.1.1. Profile and orientation
In the self-evaluation report the future Mechanical Engineer who is educated at the Eindhoven University of Technology is described as 'a science-oriented designer and a design-oriented researcher, capable of looking beyond the boundaries of disciplines, society, and countries.' To achieve this, the bachelor programme has a broad disciplinary basis without fixation on any particular application so that the graduates learn that their disciplinary knowledge and skills are widely applicable in a variety of fields and contexts.

1.1.2. Domain-specific framework of reference
The three collaborating programmes in Mechanical Engineering at the Eindhoven University of Technology (TU/e), Delft University of Technology (TUD) and the University of Twente (UT) have decided to use the ABET (Accreditation Board for Engineering and Technology) criteria as the basis for their domain-specific framework of reference, and to add the definition documents of the OECD (Organisation for Economic Co-operation and Development) and ASME (American Society of Mechanical Engineers).

The ABET criteria define the necessary elements of the curriculum: 'The curriculum must require students to apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations); to model, analyse, design, and realise physical systems, components or processes; and prepare students to work professionally in both thermal and mechanical systems areas.' The Tuning-AHELO Conceptual Framework of Expected/Desired Learning Outcomes in Engineering, published by the OECD in 2011, adds an emphasis on engineering skills in practice (theory and application), analysis (products, processes and methods) and design (apply knowledge to develop designs). ASME looks at what is expected of the future mechanical engineer (2028) who will be confronted with the challenges faced by society in developing sustainability, engineering large and small-scale systems, the competitive edge of knowledge, collaborative advantages, the nano-bio future, regulating global innovation, the diverse faces of engineering, designing at home and engineering for the other 90%. For a full description of the domain-specific framework of reference, see Appendix 2.

A benchmark of the three Dutch programmes and three foreign programmes (ETH, KTH, University of Michigan) shows that the disciplinary focus of the Dutch programmes is quite comparable. The committee feels that the cooperation between the three universities of technology (the 3TU-cooperation) is a strong point. The committee advises to use this co-operation to maintain a common basis for the programmes in mechanical engineering and make student exchange between the three departments possible, while also allowing specific emphases per institute. The committee is of the opinion that analyses of the perceived strengths of these institutes related to the assessment standards would contribute significantly to the self-evaluation and would possible serve as indicators for the future development of the Eindhoven programmes.

1.1.3. Intended learning outcomes

The final qualifications for the bachelor and the master programmes are described in terms of intended learning outcomes. The self-evaluation report describes it as follows: 'The programme provides graduates with the knowledge, skills and academic attitude that enables them to become Mechanical Engineers in a broad range of professions (from designer of industrial processes to academic researcher in engineering sciences).' 'The basis of the professional skills of the individual Mechanical Engineers rests on integrated education in the core disciplines Mechanics, Physics, Mathematics, and Chemical Engineering, interwoven with research. After completing the Master's degree, the engineer will be capable of working and thinking independently at an academic level suitable for a career as, for example, a research worker, developer, or designer in business or a research institute, or for studying for a Doctorate.' See Appendix 3 for an overview of the final qualifications for the bachelor and the master programme.

These intended learning outcomes have been related to the academic competences defined in the Academic Competences and Quality Assurance (ACQA) project, developed at the TU/e and subsequently adopted by the 3TU. The ACQA-competences require that a graduate is competent in one or more scientific disciplines, in doing research, in designing, has a scientific approach, possesses basic intellectual skills, is competent in co-operating and communicating, and takes account of the temporal and social context.

The committee appreciates that the first three of the general ACQA-descriptions have been detailed for the bachelor programme in a full description of the required disciplinary knowledge and research and engineering skills per year. A similar elaboration for the master programme depends on the individual programme composition and has not been made.

In an annex to the self-evaluation report the programme has provided an overview of the intended learning outcomes, the ACQA-competences and the Dublin descriptors. This shows that the final qualifications for the bachelor and the master programme are in line with the international standards as described in the Dublin descriptors.

1.2. Considerations

On the basis of the documentation provided and the discussions with students and staff the committee concludes that both the bachelor and the master programme have a strong academic profile. The ACQA-project has clearly been useful to translate the criteria for academic education into competences and to provide a basis for discussions among staff in order to ensure that these are indeed part of the curriculum.

The international standards for the bachelor and master level are reflected in the intended learning outcomes, both in general terms (Dublin descriptors) and more specifically for the domain of Mechanical Engineering (ABET, OECD, ASME). On this basis the graduates of the bachelor and the master programme should indeed be the science-oriented designer and design-oriented researcher that the programme aims to deliver.

1.3. Conclusion

Bachelor's programme Mechanical Engineering: the committee assesses Standard 1 as good.
Master's programme Mechanical Engineering: the committee assesses Standard 1 as good.

Standard 2: Teaching and learning environment
The curriculum, staff and programme-specific services and facilities enable the incoming students to achieve the intended learning outcomes.

Explanation:
The contents and structure of the curriculum enable the students admitted to achieve the intended learning outcomes. The quality of the staff and of the programme-specific services and facilities is essential to that end. Curriculum, staff, services and facilities constitute a coherent teaching-learning environment for the students.

2.1. Findings

This section on the teaching and learning environment examines whether the curriculum, staff and facilities enable students to achieve the intended learning outcomes. Aspects that will successively be discussed are: the structure of the curriculum (2.1.1), didactic principles (2.1.2), feasibility (2.1.3), staff (2.1.4), programme-specific facilities (2.1.5) and programme-specific quality assurance including the improvement measures that have been taken in response to the previous evaluation (2.1.6).

2.1.1. Structure of the curriculum

The bachelor curriculum as described in the self-evaluation report is replaced by a new curriculum, of which the first year has started in the 2012-2013 academic year. The committee's terms of reference are to assess the quality of a programme, on the basis of which the university applies for it to be re-accredited for the next six years. It is too early to assess the quality of the new programme. The committee has therefore decided to focus on the curriculum as described in the self-evaluation report and as experienced by the students whom the committee met during the site visit and, in addition, to indicate on the basis of the existing quality its degree of confidence in the new curriculum.

The 2011-2012 bachelor programme consists of 90 EC coursework, 51 EC Design Based Learning (DBL), 9 EC Bachelor Final Project (BFP) and 30 EC minor. The academic year is divided into four quartiles of 15 EC each. Courses are organised in units of 3 EC, while the DBL projects and training blocks are of varying size. The individual part of the bachelor curriculum consists of the minor and the BFP.

In the compulsory coursework this curriculum combines mathematical, physical, chemical and mechanical engineering disciplines and it also ensures that in each quartile at least one of the three sub disciplines (Mechanics and Materials; Energy and Flow; Systems and Control) is represented. To teach the necessary research and design skills the programme provides projects in DBL and training in the use of tools. For the individual study programme students may select a minor from a wide list as determined by the Department Board. If a student wishes to study another minor, permission must be asked from the Board of Examiners. The BFP is an individual assignment, executed in one of the research groups under the supervision of an academic staff member. For an overview of the curriculum see Appendix 4.

In 2011 a survey was executed among the teaching staff of the bachelor and the master programmes to investigate if all the ACQA-competences were represented in the curriculum. The outcomes show that all seven areas are addressed. Most time in terms of credits is spent on 'competent in one or more scientific disciplines' and 'has a scientific approach', followed by 'competent in designing', 'has basic intellectual skills', and 'competent in doing research'. Less time is spent on 'competent in co-operating and communicating' and the least on 'takes account of the temporal and the social context'.
The further disciplinary elaboration for the bachelor programme has been done well. The committee would have wished to see a similar elaboration for the master programme. The

committee is confident that on the basis of this structure the intended learning objectives of the bachelor programme will be achieved. The combination of coursework and projects provides a good balance between theory and practice.

The Department of Mechanical Engineering had started a process of redesigning the bachelor programme in 2010 on the basis of the ACQA-criteria and an evaluation among professors, teachers and students. Almost at the same time the Executive Board of the TU/e installed a task force to study the possibility to improve the bachelor education in all programmes. These two developments were brought together and the outcome is that the new bachelor curriculum, starting in 2012-2013, is part of the TU/e Bachelor College.

In the new programme all courses are to be offered in units of 5 EC. The new curriculum (see annex 4) consists of

1. a university-wide base (30 EC) of courses in mathematics, physics, design, engineering and modelling, social sciences and professional skills;
2. a major (90 EC) containing all discipline-specific courses;
3. 15 EC to be chosen from courses in the field of USE (User, Society, Enterprise);
4. 45 EC elective courses chosen by the student and approved by the Board of Examiners. The courses may be chosen in the field of the major programme but a student may also select courses from other departments to broaden the scope of his/her bachelor programme.

The committee has discussed the new curriculum with the programme management, the Education Committee and the teachers. The structure is well-considered and coherent. The committee was at first doubtful about the basic courses because they might not be sufficiently tailored to the disciplinary needs of mechanical engineering. Especially the attention paid to mathematics seemed too limited even though it was explained that much of the mathematics was integrated into the other courses and projects. The further explanation that the mathematics courses are not the same for all bachelor programmes but tailored to groups of disciplines and that they are taught and assessed by lecturers of the Department of Mathematics who keep the overview of the contents in the whole bachelor programme of Mechanical Engineering, convinced the committee that this can work out well. The strong points of the old programme, specifically the DBL-projects, are maintained and the greater freedom of choice is expected to be attractive to students. Attention is needed, however, for students who choose a different master programme than they originally intended and, therefore, may not have followed all the required courses.

Alumni mentioned in their meeting with the committee that there should have been more attention for the soft skills in the programme. The amount of time spent on USE in the old bachelor programme is indeed rather limited. The new curriculum devotes more explicit time to these aspects, which the committee considers to be an improvement.

Analytical and academic skills are trained in the DBL projects. Elements are report writing, critical reflection, presentations, peer review, academic debate and ethics. Master students who are admitted with a bachelor degree from TU/e are therefore well prepared for the academic work that is expected from them in the master programme. This is not always the case with students with a different background, especially students from abroad. The committee recommends special attention for this group, possibly by offering a short bridging programme focussing on these academic skills.

The master programme consists of 45 EC elective courses, 15 EC internship, 15 EC individual space and 45 EC graduation project. At the start of the master programme the student chooses a research specialisation and a related study track. There are three study tracks directly related to the research specialisations:

1. Computational and Experimental Mechanics (CEM), related to Mechanics and Materials;
2. Dynamical Systems Design (DSD), related to Systems and Control;
3. Thermo Fluids Engineering (TFE), related to Energy and Flow.

In addition, there are four special cross-cluster tracks:

4. Fluid and Solid Mechanics (in collaboration with TUD and UT);
5. Polymers and Composites (in collaboration with the Department of Chemical Engineering);
6. Automotive Engineering Science;
7. Micro and Nano Technology.

After having chosen a track the student chooses a graduation professor who takes responsibility for composing the student's graduation programme. The student puts together a programme and presents this to a professor for approval. The programme includes elective courses, internship, individual study space and the graduation project. The programme must be approved by the Board of Examiners.

The elective courses must be selected from a list. Each track has a set of recommended elective courses. If a student wishes to select another course he/she needs the approval from the Board of Examiners. The internship can have different forms depending on the student's background and interest. Students told the committee that they are stimulated to go abroad. The individual study space (15 EC) can be used for additional courses, an extensive literature study or an additional (or extension of the) internship period. The graduation project is an individual project, executed within one of the research groups.

The learning objectives of the internship are determined in advance by the student and the graduation professor and laid down in an agreement. The outcomes of the internship have to be described in a compact written report (in principle in English). Also the underlying project description must be included in the report. The assessment is based on four criteria. Firstly, on the level of planning, drive and self-reliance, i.e. the motivation and dedication to come to the best possible result. Secondly, the student's analytical skills. Finally, the written report and the oral presentation (colloquium) are distinctive elements to be assessed.

During the graduation project the student will gain considerable in-depth scientific knowledge and competences. This project can be carried out in one of the research laboratories of the department (generally in close cooperation with a PhD student) or in industry. During the graduation project, the student must learn to apply a scientific way of working, in a creative manner, to the solution of problems. The student's work should be based on and/or extend the expertise and skills acquired so far.

The committee finds the curriculum of the master programme well-structured and coherent. It gives the students a lot of choice, but within clear boundaries defined by their study track and their graduation professor. There is a strong focus on research and analytical skills, which fits the academic profile of the programme.

2.1.2. Didactic principles

The bachelor courses are a combination of lectures and guided self-study or instruction. During the guided self-study groups of approximately 40 students practise the concepts presented in the lectures, under the guidance of a lecturer. The main objective is to guide students into generalising principles, rules and procedures so that they can make deductions and apply them in new situations.

A distinctive feature of the bachelor programme is Design-Based Learning (DBL), where students work together in groups of 8-10 students on design problems. Students appreciate this kind of learning and are satisfied with the assignments, the guidance by tutors and the assessment. They were especially positive about the peer review training where they learned to assess each other. As a point of criticism they mentioned that in some cases the group was too large for the amount of work needed to solve the project case.

The committee appreciates the individual Bachelor Final Project (BFP) of 9 EC. This is a substantial piece of work where students are required for the first time to do an individual project and to produce an academic report. The committee regards this as a good preparation for the master programme.

Very good students can participate in the department's special Honours Programme, called Star. The staff explained that students in the Star Programme are presented with slightly more difficult projects in DBL and can do a special Honours minor abroad. The staff is also working on Honours BFPs. The Star Programme is now running for the third year but it is as yet unclear if or how it will be organised in the new bachelor curriculum.

The master courses are based on lectures. Instead of the guided self-study in the bachelor programme master students can use walk-in hours of the lecturers when they have questions. Students and lecturers informed the committee that students use this opportunity frequently.

The didactical approach of the bachelor programme stimulates the integration of theoretical knowledge (lectures and guided self-study) with its application in design problems (DBL) and research (BFP). The didactical approach of the master programme stimulates the students to make decisions about the objective of their study. It is a much more individualised programme and works toward independent work, in the internship and the graduation project. The committee considers the didactical approach to be in line with the learning objectives of the bachelor and the master programme.

2.1.3. Feasibility

The curriculum is a demanding programme and very few students manage to graduate in the nominal time. The average study duration for the bachelor and master programme combined is a little more than seven years. Nevertheless, the committee considers the programme to be feasible. Students admit that it is possible to finish on time if they work hard, i.e. spend an average of forty hours per week on their study

There are a few courses in the bachelor programme that are known to be stumbling blocks. For these courses additional measures have been taken, such as extra tutoring and providing small assignments during the course to prepare for the final exam. The BFP used to take much longer than planned. To remedy this, a strict deadline has been set. The BFP must be finished within two quartiles. Extension can only be granted after consultation of the study counselor, project supervisor and BFP coordinator. In the 2011-2012 academic year this has already resulted in a much larger proportion of timely finished projects, but this was probably also an effect of the 'langstudeerdersboete', proposed by the government. Due to political changes, this measure has been withdrawn. The department should monitor closely next year if the improvement in study behaviour will be maintained.

First-year students must have completed at least 30 EC to be allowed to continue their studies. If they have completed less than 30 EC they are given a negative Binding Study Advice (BSA). The committee understands that the 30 EC limit has been established by the Board of the University, but finds this limit not very ambitious. The committee thinks that 30 EC is not very demanding and would advise to raise this to e.g. 45 EC, also regarding the aim of a bachelor success rate of 70% in 2020, as mentioned by the Dean during the site visit. It would be better if this aim were achieved earlier than in 2020.

The university has decided to introduce the 'harde knip' per September 2012. This is the requirement that students must have completed the bachelor programme before they may start their master courses. For some students this has come as a surprise and they needed to complete their bachelor degree before the start of the new academic year while there were no more re-sits for the exams they had missed. The Department of Mechanical Engineering has been very inventive in finding suitable ways to solve this situation. In some cases extra individual re-sits were allowed. In other cases students could register the master courses they had already completed, as bachelor courses instead. In future, for students who have almost completed the bachelor programme and are only a limited number of ECs short, appropriate individual measures will be taken, for instance allowing an extra re-sit. In this way the department tries to prevent unnecessary study delays.

In the master programme the internship is frequently mentioned as a source of delay, especially when it is an international internship. Students often spend more time abroad than the time equivalent of the official 15 EC. The individual study space (15 EC) can be used to extend the internship, on the basis of an addition to the project plan. Another source of delay is when the elective courses a student has selected are taught while he/she is away. In that case they have to do the course in the following year or select another elective course. The committee thinks that the number of elective courses is large enough to make alternative choices possible and would advise the students in such cases to use their time efficiently and choose another course, in consultation with their graduation professor.

2.1.4. Staff

The academic staff of the department is at an appropriate level, quantitatively and qualitatively. The student/staff ratio is approximately 17:1. This is slightly better (lower) than at the time of the previous assessment. Many staff members, however, still complain about the high work load. The redesign process of the bachelor programme adds to the work load. In the meeting with staff members during the site visit the committee noted that staff is aware that change is unavoidable and lack of change is even undesirable, and that motivation remains high.

The student interest is not evenly distributed over the research groups and professors. Students, therefore, cannot always do the BFP of their first choice. The committee finds this acceptable for the bachelor phase. The self-evaluation report mentions in two places that the non-equal distribution of graduate students over the research groups is a problem and that this, in future, may limit their free choice of graduation professor. The committee naturally agrees that the quality of the graduation projects must be guaranteed, but recommends that creative solutions will be investigated instead, such as the delegation of day-to-day supervision to PhD students and two-weekly sessions with the professor, as currently practiced by one of the professors with a large group of graduate students. The limitation of free choice of graduation professor can only be a last resort.

Approximately 20% of the staff members have part-time appointments and work in industry. Other staff members have frequent contacts with companies through the internships and graduation projects of their students. The focus of internships is on international placements and research institutes rather than industrial companies.

The University Teaching Qualification (UTQ) is required from new staff members, from those who are considered for a promotion and from staff members who perform below standard expectations (e.g. after continued low scores in course evaluations). This means that many faculty members are not stimulated to obtain the UTQ while the committee thinks it could be very useful also for experienced lecturers. The committee advises to look for a creative and efficient approach based on best practices, e.g. afternoon sessions or workshops, where staff members can reflect together on their teaching methods and build their portfolio.

2.1.5. Programme-specific facilities

The newly renovated buildings of the Department of Mechanical Engineering provide staff and students with good facilities for teaching and training. In addition, the department has excellent research facilities which are accessible for the master students, especially during their master thesis projects. The laboratories and the DBL-rooms are well-equipped and there are many spaces for individual study. Students are provided with laptops and up-to-date software at very reasonable prices.

The coaching and counselling provided to students is exemplary, especially with regard to their proactive approach. Every first year bachelor student is assigned a study coach who is on the departmental academic staff. The study coaches meet with their students four times throughout the year, and more often in cases of potential study delay. The study coach is always in direct contact with the DBL-tutor of the students, usually in weekly meetings. The study coach also attends one or more of the DBL-meetings to get a better impression of his/her students. For more intensive or specialised counselling students are referred to one of the student counsellors. One counselor focuses on the first- and second-year students and the BSA, a second one supports students in the transition from bachelor to master phase ('harde knip") and the Dutch master students (year 3 and beyond), and a third counselor is appointed specifically for the international master students. Students are expected to take the initiative to contact the counsellors, but if they do not and if their marks are below expectations, the counsellors take the initiative. Students expressed to the committee their appreciation for the personal approach and the open atmosphere. They feel they can always contact a staff member with questions.

Recently the study progress seems to have improved and success rates have increased. Staff is not certain if this can be ascribed to the intensive counselling, BSA and 'harde knip'. The committee advises the department to monitor the results systematically and to publish their conclusions to the benefit of other departments and universities.

The Education Bureau formally checks the study tracks and individual graduation programmes of the master students when they have been agreed upon with the graduation professor. Students mentioned in their meeting with the committee that they are not always aware of these formal regulations. The committee advises to improve the information to students about this.

2.1.6. Programme-specific quality assurance

Quality assurance is taken seriously by the programme. The quality control officer keeps track of the courses that need to be evaluated per quartile. Apart from regular, scheduled evaluations (once every 3 years), recommendations from the Education Committee and students, and requests of lecturers (new) courses are added to list. The quality control officer conducts the evaluations among students and processes the results. The outcomes are discussed by the Education Committee and, if necessary, follow up actions are taken. The evaluation response rates are sometimes rather low. In smaller courses, such as in the master programme, this is a serious problem. The committee advises to provide incentives for the participation in course evaluations.

The student members of the Education Committee represent students' opinions and are contacted by students if things do not work out as expected.

The committee advises the Education Committee to ensure better course descriptions for the master courses, comparable to the detailed bachelor course descriptions. The learning objectives of the master courses are at present not described in terms of competences or other identifiable learning outcomes, but are limited to a list of topics addressed in the course.

In response to the previous assessment report in 2007 several measures have been taken. The study facilities have been updated and the student/staff ratio has been reduced. The quality assurance cycle has been fully embedded in the programme. The selection in the bachelor programme has been increased by the introduction of the BSA and students are informed intensively about the possibilities in the master programme. The master programme provides more choice: 45 EC of elective courses instead of 33 in 2007. The master graduation project is now 45 EC (previously 60 EC). The individual study period can be used for an extension of the internship. The introduction of the 'harde knip' will allow the programme to keep better track of the study duration of master students, which was expected to be necessary because of the 'langstudeerdersboete' proposed by the government. New political developments, however, have led to the withdrawal of this measure. In addition, other measures have been taken to improve the programme. The committee recognises this as a sign of the department's drive towards continuous improvement.

2.2. Considerations

The committee has investigated the different aspects of the teaching and learning environment to assess whether the intended learning objectives can be achieved. The meetings with students, staff and the Education Committee gave clear information about the implementation of the bachelor and master programmes.

The bachelor programme is well-structured and provides the necessary foundation in theory and skills. The five basic courses in the newly started revised curriculum are taught as general courses for all students of the university and the committee doubted at first if these would give a strong enough basis for mechanical engineering. Further information reassured the committee on this point. The new programme provides more choice than the previous one. The committee regards this as a strong point, because it will be more motivating for students and will give them better opportunities to switch to another programme if their first choice does not prove to suit them. This larger freedom of choice may lead to some problems in the transition to the master programme, when students have not followed all the required courses to prepare them for a specific master study track. The department should prepare for such transitional issues in a timely manner, e.g. by providing extra study material for these students.

The DBL projects are characteristic for the TU/e programme in Mechanical Engineering. They help the students not only to connect theory to real-life design problems but also to develop academic and social skills. The tutors play an important role, are able to keep track of the students' progress and can, if necessary, refer a student to the student counsellor.

The committee considers the BFP an important part of the programme, especially because it requires the individual students to independently produce a substantive piece of work that must conform to academic criteria. Until recently, BFPs tended to take (much) longer than planned.

The master programme is highly individualised. Under the guidance of their graduation professor students select a coherent set of coursework, internship and graduation project. The committee finds this a suitable approach for the master phase where the individual student's plan for a career should be leading. Therefore, the uneven distribution of students' interest for the different research groups and professors should only lead to a limitation of the free choice of graduation professor as a last resort.

The teaching and the supporting staff are strongly involved with the students and their progress. The committee recognised the commitment of lecturers, even in times of heavy work load as a result of the re-design of the bachelor programme. The proactive approach by the student counsellors and the role of the study coaches in the first year are strong points.

The average length of study remains a concern. The feasibility of the programme is in order, even though only a minority of the students finishes on time. The students indicate that they often give priority to other activities, such as the student association, sports, study trips or jobs. The committee expects that new measures such as the Binding Study Advice (BSA) and the 'harde knip' will lead to improved study behaviour. The programme staff has taken sufficient measures to help students with study delays.

The systematic quality assurance cycle and the openness of staff to comments and criticisms of students ensure that the bachelor and master programmes continue to evolve and improve.

2.3. Conclusion

Bachelor's programme Mechanical Engineering: the committee assesses Standard 2 as satisfactory.
Master's programme Mechanical Engineering: the committee assesses Standard 2 as satisfactory.

Standard 3: Assessment and achieved learning outcomes
The programme has an adequate assessment system in place and demonstrates that the intended learning outcomes are achieved.

Explanation:
The level achieved is demonstrated by interim and final tests, final projects and the performance of graduates in actual practice or in post-graduate programmes. The tests and assessments are valid, reliable and transparent to the students.

3.1. Findings

This section consists of two parts. First, it deals with the committee's findings with regard to the system of assessment (3.1.1). Secondly, it answers the question of whether students achieve the intended learning outcomes (3.1.2).

3.1.1. Assessment system

All bachelor courses are examined by written exams, composed and assessed by teams of lecturers under supervision of the responsible lecturer. The four-eyes principle is therefore ensured, but the committee missed test matrices in the course descriptions. These would provide the necessary transparency and guarantees for validity and reliability. The Board of Examiners indicated that transparency is provided to students because all previous exams and the elaborated answers are made available. Test matrices for all courses will be on the agenda later this year, not only in the Department of Mechanical Engineering, but in the TU/e as a whole, as part of the new bachelor college. The intention of the Board of Examiners to start checking the quality and level of all assessments randomly is a good idea.

The assessment of DBL projects is a combination of a group component and an individual component. The group component relates to the group product, often a report, and is assessed by the project coordinator. The individual component is assessed by the tutor and, after a peer review training in the third quartile, by the group. Students expressed their satisfaction with this assessment system and find it very instructive for their own improvement. The committee has not seen any indications of 'free rider' behaviour.

The BFP is assessed on the basis of the report and a presentation. The presentation is attended and discussed by more than one staff member but the final grade is decided by the supervisor. The assessor must be an authorised examiner. A BFP is evaluated on four aspects: planning, drive and self-reliance; analytical skills, written report, and oral presentation. All four aspects are assessed independently from one another. The final grade is the average of the four marks. The committee found that at least in one case the assessment was given by a PhD student and that the arithmetic is not consistently applied. In addition, not all BFP reports were in line with the formal criteria of academic reports. In most cases, even the very good ones, the reference list was very limited and in one case the product was not an academic report but a practice-oriented manual. The committee discussed the latter with the responsible staff member and the Board of Examiners which was not aware of the case. The committee therefore recommends that the Board of Examiners check the procedures and awarded grades more actively.

Master courses are assessed with a written or oral exam, an assignment or a combination of these. Oral exams are usually executed by two examiners, but this can also be done by a single examiner unless the student objects.

The master graduation projects are always assessed by three examiners. One of these is an independent examiner from another research group or an external examiner. The composition of these graduation committees is checked by the Board of Examiners. The final mark is decided on the basis of consensus and is based on seven aspects: demonstrated analytical engineering skills; theoretical/practical/technical skills; creativity; independence; the written report; oral presentation; and the final defence before the graduation committee. The final mark is not automatically the average of the sub marks but is the outcome of the deliberations of the graduation committee. Thus one or more aspects can be given more weight in order to better express the overall quality of the student and his/her work. The final mark may not differ more than 0.5 from the average of the sub marks. In two cases the marks for the different aspects varied widely: two aspects, including analytical skills, were given a non-passing mark which were then compensated by higher marks, e.g. for oral presentation or written report. These two cases involved international students who apparently lacked the academic training provided in the bachelor programme. The committee advises the department to ascertain the strength of the bachelor education of international students before admission and, if necessary, to provide additional training.

The department tries to prevent fraud by strict invigilation rules during exams and by the use of a software programme to detect plagiarism in submitted assignments and reports. Staff members are so closely involved in the work of students that they regard it highly unlikely that plagiarism would go undetected.

3.1.2. Achievement of intended learning outcomes

During the site visit all bachelor examinations including the students' answers were available for inspection by the committee. They were found to be at an adequate level and well-marked.

The committee checked fifteen BFP reports and fifteen master theses to assess if the intended learning outcomes are achieved.

The quality of the BFP reports showed a lot of variation. In a few cases, mentioned above, the accepted formal rules for academic reporting had not been followed. The committee advises the staff to make these expectations more explicit to students and to check their implementation. Besides this, the quality of the project work was generally satisfactory to good and the marks given by staff were in line with the committee's assessments.

The quality of the master theses was also satisfactory to good. The committee's assessments were at the same level as the original grades. The progression in complexity, analytical skills and scientific writing from bachelor theses to master theses was large. The committee was impressed by the number of scientific publications as a direct result from the master theses: 120 over the past five years. This reflects the academic level of the graduation projects.

Recent alumni surveys show that approximately 80% find jobs on the academic level. Between 40-50% find a job immediately after graduating. About 80% feel well prepared for the labour market. A large majority (86%) think that their education has contributed to the good base for entering the job market and that it has given them the ability to further develop their knowledge and skills.

These positive outcomes were supported by the alumni whom the committee met during the site visit. As particularly strong points they mentioned that they had learned to apply theoretical knowledge to practical engineering problems and the broad disciplinary foundation they had been taught. They would have liked a more structural approach to the teaching of soft skills and ethics. This is part of the DBL projects but should be more systematic and structural. They remarked that students should be stimulated more often to find an external internship. In the opinion of the alumni this is left too much to the initiative of the students themselves and students are allowed to do their internship at the TU/e or a research institute such as TNO while they should experience the different way of working in industry.

3.2. Considerations

The committee has looked into the assessment system and the bachelor and master theses in order to answer the question of whether the intended learning outcomes are achieved. The committee is convinced that the assessment system is sufficiently valid and reliable even though a formal check on the implementation of rules and regulations is sometimes missing. The committee advises to develop test matrices to provide the necessary transparency and guarantees for validity and reliability. Addressing some assessment issues on a more structural basis starting this year, as the Board of Examiners' intends to, will be an improvement.

The theses are at the required level of an academic bachelor and master programme. Bachelor graduates are well-prepared to continue their studies in an academic master programme and master graduates have a good foundation for a career as a science-oriented engineer or as a design-oriented scientist.

3.3. Conclusion

Bachelor's programme Mechanical Engineering: the committee assesses Standard 3 as satisfactory.
Master's programme Mechanical Engineering: the committee assesses Standard 3 as good.

General conclusion

The committee judges the bachelor and master programmes in Mechanical Engineering to be solid and stimulating academic programmes. The design of the programme structure, the way it is taught by qualified and committed staff members, and the conditions created for quality control all contribute to a fitting teaching and learning environment. The assessment of the learning outcomes in tests, assignments and, above all, the bachelor and master thesis meets the required academic quality standards. Both the quality of the theses and the experiences of the alumni show that the intended learning outcomes are achieved.

The committee assesses the *bachelor's programme Mechanical Engineering* as satisfactory.
The committee assesses the *master's programme Mechanical Engineering* as good.

Appendices

Appendix 1: Curricula vitae of the members of the assessment committee

Joris De Schutter (chair) received the M.Sc. degree in mechanical engineering from the Katholieke Universiteit Leuven, Belgium, in 1980, the M.Sc. degree from the Massachusetts Institute of Technology, in 1981, and the Ph.D. degree in mechanical engineering, also from KU Leuven, in 1986. Following work as a control systems engineer in industry, in 1986, he became a lecturer in the Department of Mechanical Engineering, KU Leuven, where he has been a full professor since 1995. He teaches courses in kinematics and dynamics of machinery, control, robotics and optimisation. His research interests include sensor-based robot control and programming, optimal motion control of mechatronic systems, and modeling and simulation of human motion. In 2000-2001 he spent a sabbatical year in industry (environmental technology). From 2001 to 2003 he was president of K VIV, the Flemish association of university-graduated engineers.

Gijs Calis received his master's degree in Mechanical Engineering (Production Automation) from Eindhoven University of Technology in 1974. He held various management positions within the Stork group of companies as of 1974. His latest position was Corporate Director Risk Management, Stork B.V.; Corporate Head Office (2002 – 2010).
He retired in April 2010. His current other positions include being the chairman of the Division of Mechanical Engineers of the Royal Institute of Engineers in The Netherlands; vice-chairman and arbitrator of the Council of Arbitration for the Metal Trade and Industry; and chairman of the Policy Committee 'Machinebouw' of NEN, the standardisation institute of the Netherlands. Formerly he was a member of the Advisory Board of the Graduate School of Engineering Mechanics in the Netherlands (1996 -2011) and a member of the Advisory Committee to the Faculty of Mechanical Engineering of Delft University of Technology (1996 - 2000) and the UHD committee of this Faculty (2000 – 2005).

Hetty Grunefeld has a master's degree in Computer Science from the University of Twente (1988). Since then she worked as a teacher and as educational consultant within the Faculty of Computer Science on several curriculum development and quality enhancement projects. In 1995 she started working within the Educational Centre on similar projects in e.g. Mechanical Engineering. Since 2001 she has been working as an educational development consultant at Utrecht University. She is involved in curriculum development projects and quality enhancement. She is programme leader of the prestigious course Educational Leadership that was developed by Utrecht University. She was a member of the assessment committee that evaluated the quality of the Electrical Engineering programmes (HBO, 1995) and of the committee for Economics (WO, 2009).

Hans ter Meulen was awarded a MSc in Physics from the Katholieke Universiteit Nijmegen (currently Radboud University). He specialised in experimental molecular physics at the same university, where he obtained a PhD degree in 1976 on the origins of the maser radiation from interstellar hydroxyl radicals. Hereafter he started a research group focused on molecular spectroscopy and molecular dynamics using tunable narrowband laser techniques. In 1980 he became associate professor at Nijmegen University and started with applied research in the field of both reactive and non-reactive flows. He collaborated with research groups at the universities of Delft, Eindhoven and Twente in the fields of fluid dynamics and mechanical engineering. In 1997 Hans ter Meulen became full professor in Applied Physics at Nijmegen University. Beside research he has been involved intensively in the science education programmes. He chaired the education committee for Physics for many years. From 1995 onwards he has coordinated the programme of Science, a new broad study programme at Nijmegen. From 2005 to 2008 he was the director of the education institute for Physics and Astronomy and from 2008 to 2011 he was vice-dean for education at the Faculty of Science. He was retired in 2012.

Thomas Opraus is currently enrolled in the bachelor programme Mechanical Engineering at Delft University of Technology. He has been a board member of the study association 'Gezelschap Leeghwater', where he was responsible for the Educational Affairs of the bachelor programme. Currently he is a student member of the Education Committee of the Department of Mechanical Engineering. He is also working as a Student Assistant Education Quality assurance, at the Department of Mechanical Engineering.

Appendix 2: Domain-specific framework of reference

1. ABET

Mechanical Engineering is one of the disciplines defined by ABET. The previous self-evaluation report used the ABET criteria for its domain-specific frame of reference (DSFR). The three collaborating programmes in Mechanical Engineering at TU/e, TUD and UT have decided to add the OECD (A tuning-AHELO conceptual framework of expected/desired learning outcomes in engineering) and ASME (An Environmental Scan for ASME and the Global Summit on the Future of Mechanical Engineering) definition documents as an extension to this DSFR. Sequentially, we will discuss the proposed Learning outcomes for an Engineering programme, the proposed Learning outcomes for a Mechanical Engineering programme and the criteria for a Master's programme.

Engineering programme

Engineering has classically been defined as the profession that deals with the application of technical, scientific, and mathematical knowledge in order to use natural laws and physical resources to help design and implement materials, structures, machines, devices, systems and processes that safely accomplish a desired objective. As such, engineering is the interface between scientific and mathematical knowledge and human society. The primary activity of engineers is to conceive, design, implement and operate innovative solutions – apparatus, processes, and systems – to improve the quality of life, address social needs or problems, and improve the competitiveness and commercial success of society.

Engineering is quite different from science. Scientists try to understand nature. Engineers try to make things that do not exist in nature. Engineering Technology is of great economic importance. Although many achievements are not eye-catching and do not receive much public notice, many of the activities are essential for the proper functioning of the modern society. The engineer designs devices, components, subsystems, and systems. To create a successful design, in the sense that it leads directly or indirectly to an improvement of the quality of life, the engineer must work within constraints provided by technical, economic, business, political, social and ethical issues.

No profession unleashes the spirit of innovation like engineering. From research to real-world applications, engineers constantly discover how to improve our lives by creating bold new solutions that connect science to life in unexpected, forward-thinking ways.

Proposed learning outcomes for an Engineering programme

The OECD has launched a feasibility study, Assessment of Higher Education Learning Outcomes (AHELO), which is a ground-breaking initiative that will assess learning outcomes on an international scale by creating measures that would be valid for all cultures and languages.

A comparative summary of some of the most influential learning outcome frameworks in the engineering field is set out in Appendix 1. That there is a common understanding throughout the world of what an engineer is supposed to know and be able to do is most striking and probably differentiates engineering from many other disciplines. In a comparative review of the Tuning-AHELO, EUR-ACE Framework Standards for the Accreditation of Engineering Programmes and the ABET criteria for accrediting engineering programmes, the following learning outcomes for Engineering programmes were distinguished:

a) Generic Skills: The ability to…

- …function effectively as an individual and as a member of a team;
- …communicate effectively with the engineering community and with society at large;
- …recognise the need for and engage in independent life-long learning;

- …demonstrate awareness of the wider multidisciplinary context of engineering.
b) Basis and Engineering Sciences: The ability to…
- …demonstrate knowledge and understanding of the scientific and mathematical principles underlying their branch of engineering
- …demonstrate a systematic understanding of the key aspects and concepts of their branch of engineering
- …demonstrate comprehensive knowledge of their branch of engineering including emerging issues.

c) Engineering Analysis: The ability to…
- …apply their knowledge and understanding to identify, formulate and solve engineering problems using established methods
- …apply knowledge and understanding to analyse engineering products, processes and methods
- …select and apply relevant analytic and modeling methods
- …conduct literature searches, use databases and other sources of information
- …design and conduct appropriate experiments, interpret the data and draw conclusions.

d) Engineering Design: The ability to…
- …apply their knowledge and understanding to develop designs to meet defined and specified requirements
- …demonstrate an understanding of design methodologies, and be able to use them

e) Engineering Practice: The ability to…
- …select and use appropriate equipment, tools and methods
- …combine theory and practice to solve engineering problems
- …demonstrate understanding of applicable techniques and methods, and their limitations
- …demonstrate understanding of the non-technical implications of engineering practice
- …demonstrate workshop and laboratory skills
- …demonstrate understanding of health, safety and legal issues and responsibilities of engineering practice, the impact of engineering solutions within a societal and environmental context, and commitment to professional ethics, responsibilities and norms of engineering practice
- …demonstrate knowledge of project management and business practices, such as risk and change management, and awareness of their limitations.

Criteria for a Mechanical Engineering programme
Mechanical Engineering is a discipline of Engineering that applies the principles of physics and materials science for analysis, design, manufacturing, and maintenance of mechanical systems. It is the branch of engineering that involves the production and usage of heat and mechanical power for the design, production, and operation of machines and tools. It is one of the oldest and broadest engineering disciplines.
The engineering field requires an understanding of core concepts including mechanics, kinematics, thermodynamics, materials science, and structural analysis. Mechanical engineers use these core principles along with tools like computer-aided engineering and product lifecycle management to design and analyse manufacturing plants, industrial equipment and machinery, heating and cooling systems, transport systems, aircraft, watercraft, robotics, medical devices and more.
The field has continually evolved to incorporate advancements in technology, and mechanical engineers today are pursuing developments in such fields as composites, mechatronics, and nanotechnology. Mechanical engineering overlaps with aerospace engineering, building

services engineering, civil engineering, electrical engineering, petroleum engineering, and chemical engineering to varying amounts.

The fundamental subjects of mechanical engineering include:

Statics and dynamics	Mathematics – in particular, calculus, differential equations, and linear algebra
Strength of materials and solid mechanics	Engineering design
Instrumentation and measurement	Product design
Thermodynamics, heat transfer, energy conversion, and HVAC	Control theory and mechatronics
Fluid mechanics and fluid dynamics	Material engineering
Mechanism design (including kinematics and dynamics)	Design engineering, computer-aided design (CAD), and computer-aided manufacturing (CAM).
Manufacturing engineering, technology, or processes	

Mechanical engineers are also expected to understand and be able to apply basic concepts from chemistry, physics, chemical engineering, civil engineering, and electrical engineering. Most mechanical engineering programs include multiple semesters of calculus, as well as advanced mathematical concepts including differential equations, partial differential equations, linear algebra, abstract algebra, and differential geometry, among others.
Next, we will discuss the trend for the future of mechanical engineering and the learning outcomes for a mechanical engineering programme according to OECD.

Trends for the future of mechanical engineering according to ASME
The Institute for Alternatives Futures describes in an environmental scan for ASME and the Global Summit on the Future of Engineering mentions nine trends that will change the character of mechanical engineering in the coming decades. These nine trends play an important role in the development of our curriculum:
1. Developing Sustainably
2. Engineering Large & Small Scale Systems
3. Competitive Edge of Knowledge
4. Collaborative Advantage
5. NanoBio Future
6. Regulating Global Innovation
7. Diverse Face of Engineering
8. Designing at Home
9. Engineering for the Other 90 Percent

Criteria for a MSc level programme
The criteria of the ABET are intended to assure quality and to foster the systematic pursuit of improvement in the quality of engineering education that satisfies the needs of constituencies in a dynamic and competitive environment.
All Master's level programmes seeking accreditation from the Engineering Accreditation Commission of ABET must develop, publish, and periodically review, educational objectives and student outcomes. The criteria for master's level programmes are fulfilment of the baccalaureate level general criteria, fulfilment of programme criteria appropriate to the masters level specialisation area, and one academic year of study beyond the baccalaureate

level. The programme must demonstrate that graduates have an ability to apply master's level knowledge in a specialised area of engineering related to the programme area.
According to the ABET, an Engineering curriculum must require students to apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations); to model, analyse, design, and realise physical systems, components or processes; and prepare students to work professionally in both thermal and mechanical systems areas.
Nevertheless, generally accepted programme elements are Mechanical Automation, Control Engineering, Mathematics, Thermodynamics, Fluid & Solid Mechanics, Design Methods, Production Methods and Material Sciences. Between these accepted programme elements, there are differences in priorities between the universities. In general can be concluded that the programme must demonstrate that faculty members responsible for the upper-level professional programme are maintaining currency in their specialty area.

2. OECD

The Tuning-AHELO project on learning outcomes is the result of a comparative review of the EUR-ACE Framework Standards for the Accreditation of Engineering Programmes and the ABET criteria for accrediting engineering programmes. It is consistent with other frameworks/sets of learning outcomes, relevant for defining the Tuning-AHELO set of learning outcomes for first cycle engineering programmes in general. The corresponding ABET criteria are included between round brackets after the title of each identified group of learning outcomes.

First cycle programme learning outcomes in engineering developed in the framework of the Tuning-AHELO project:

Generic Skills (d, g, h, i)

Graduates should possess generic skills needed to practice engineering. Among these are: the capacity to analyse and synthesise, apply knowledge to practice, adapt to new situations, ensure quality, manage information, and generate new ideas (creativity). More particularly, graduates are expected to have achieved the following learning outcomes:
• the ability to function effectively as an individual and as a member of a team;
• the ability to communicate effectively with the engineering community and with society at large;
• the ability to recognise the need for and engage in independent life-long learning;
• the ability to demonstrate awareness of the wider multidisciplinary context of engineering.

Basic and Engineering Sciences (a)

In general, the underpinning knowledge and understanding of science, mathematics and engineering fundamentals are essential to satisfy other programme outcomes. Graduates should be able to demonstrate their knowledge and understanding of their engineering specialisation, and also the wider context of engineering. More particularly, graduates are expected to have achieved the following learning outcomes:
• the ability to demonstrate knowledge and understanding of the scientific and mathematical principles underlying their branch of engineering;
• the ability to demonstrate a systematic understanding of the key aspects and concepts of their branch of engineering;
• the ability to demonstrate comprehensive knowledge of their branch of engineering including emerging issues.

Engineering Analysis (b, e)
Graduates should be able to solve engineering problems consistent with the level of knowledge and understanding expected at the end of a first cycle study programme, and may involve experience from outside their field of specialisation. Analysis can include the identification, specification and clarification of the problem, determination of possible solutions, selection of the most appropriate solution method, and effective implementation. First cycle graduates should be able to use various methods, including mathematical analysis, computational modelling, or practical experiments, and should be able to recognise societal, health and safety, environmental and commercial constraints. Furthermore, graduates should be able to use appropriate research or other detailed investigative methods of technical issues consistent with the level of knowledge and understanding expected at the end of a first cycle study programme.
Investigation may involve literature research, design and execution of experiments, interpretation of data, and computer simulation. It may require that databases, codes of practice and safety regulations are consulted. More particularly, graduates are expected to have achieved the following learning outcomes:
• the ability to apply their knowledge and understanding to identify, formulate and solve engineering problems using established methods;
• the ability to apply knowledge and understanding to analyse engineering products, processes and methods;
• the ability to select and apply relevant analytic and modelling methods;
• the ability to conduct literature searches, use databases and other sources of information;
• the ability to design and conduct appropriate experiments, interpret the data and draw conclusions.

Engineering Design (c)
Graduates should be able to create engineering designs consistent with the level of knowledge and understanding expected at the end of a first cycle study programme, working in co-operation with engineers and non-engineers. The design may be of processes, methods or artefacts. The specifications should be wider than technical aspects, including awareness of societal, health and safety, environmental and commercial considerations. More particularly, graduates are expected to have achieved the following learning outcomes:
• the ability to apply their knowledge and understanding to develop designs to meet defined and specified requirements;
• the ability to demonstrate an understanding of design methodologies, and be able to use them.

Engineering Practice (f, j, k)
Graduates should be able to apply their knowledge and understanding to developing practical skills for solving problems, conducting investigations, and designing engineering devices and processes. These skills may include the knowledge, use and limitations of materials, computer modelling, engineering processes, equipment, workshop practice, and technical literature and information sources. They should also recognise the wider, non-technical aspects, such as ethical, environmental, commercial and industrial, implications of engineering practice, ethical, environmental, commercial and industrial. More particularly, graduates are expected to have achieved the following learning outcomes:
• the ability to select and use appropriate equipment, tools and methods;
• the ability to combine theory and practice to solve engineering problems;
• the ability to demonstrate understanding of applicable techniques and methods, and their limitations;

• the ability to demonstrate understanding of the non-technical implications of engineering practice;
• the ability to demonstrate workshop and laboratory skills;
• the ability to demonstrate understanding of the health, safety and legal issues and responsibilities of engineering practice, the impact of engineering solutions within a societal and environmental context, and commitment to professional ethics, responsibilities and norms of engineering practice;
• the ability to demonstrate knowledge of project management and business practices, such as risk and change management, and awareness of their limitations

3. ASME
ASME (American Society of Mechanical Engineers) prepared a document in 2008, looking ahead at the challenges expected in 2028.

The nine drivers of change described in the report grapple with many of the grand challenges faced by society over the next twenty years. They reflect the needs, wants and desires of people around the globe. They also explore what mechanical engineering will need to do well in order to do this good work in the world. For each driver, IAF (Institute for Alternative Futures) offers a forecast of what might happen and explains how these changes could affect mechanical engineering.

Here are the nine drivers and forecasts briefly summarised.

1. Developing Sustainably: Rapidly developing economies are adding to global environmental pressures and competition for energy, water, and other high-demand resources. Mechanical engineering will be challenged to develop new technologies and techniques that support economic growth and promote sustainability.

2. Engineering Large & Small Scale Systems: Engineers in 2028 will work at the extremes of very large and very small systems that require greater knowledge and coordination of multidisciplinary and multi-scale engineering across greater distances and timeframes. A new field of systems engineering will incorporate much of the knowledge and practices of mechanical engineering.

3. Competitive Edge of Knowledge: In 2028, the ability of individuals and organisations to learn, innovate, adopt and adapt faster will drive advanced economies. Mechanical engineering education will be restructured to resolve the demands for many individuals with greater technical knowledge and more professionals who also have depth in management, creativity and problem-solving.

4. Collaborative Advantage: The dominant players in all industries in 2028 will be those organisations that are successful at working collaboratively. The 21st century will be defined by the integration of competitive markets with new methods of collaboration.

5. NanoBio Future: Nanotechnology and biotechnology will dominate technological development in the next 20 years. In 2028, nanotechnology and biotechnology will be incorporated into all aspects of technology that affect our lives on a daily basis. They will provide the building blocks that future engineers will use to solve pressing problems in diverse fields including medicine, energy, water management, aeronautics, agriculture and environmental management.

6. Regulating Global Innovation: Innovation, within the framework of a global economy, will remain a complex affair in 2028. Fundamental restructuring of the regulation and protection of intellectual property on a global basis is unlikely. As more complex technologies require greater collaboration and sharing of patents, incremental changes will occur to produce equitable and beneficial results for the innovators and those that adopt and commercialise innovations.

7. Diverse Face of Engineering: Demand for new technologies will sustain global demand for adequately skilled and innovative mechanical engineers in 2028. Prospective employers will seek and promote people with unique and varied backgrounds to maximise their potential for success in diverse cultures and situations.

8. Designing at Home: By 2028, advances in computer aided design, materials, robotics, nanotechnology and biotechnology will democratise the process of designing and creating new devices. Engineers will be able to design solutions to local problems. Individual engineers will have more latitude to design and build their devices using indigenous materials and labor – creating a renaissance for engineering entrepreneurs. The engineering workforce will change as more engineers work at home as part of larger decentralised engineering companies or as independent entrepreneurs.

9. Engineering for the Other 90 Percent: By 2028, globalisation and new business models will increasingly drive the development of mechanical engineering projects that serve the poorest 90 percent of humanity – the four billion people who live on less than $2 a day.

Appendix 3: Intended learning outcomes

A graduate of the BSc in Mechanical Engineering:

1. is formed within the academic domain of science, engineering and technology;
2. is able to investigate and design under supervision;
3. recognises the importance of other disciplines (interdisciplinarity);
4. has a scientific approach to problems and ideas based on existing knowledge;
5. possesses intellectual skills, can be guided to reflect critically, reason logically and come to judgments;
6. can communicate results of his/her own learning, thinking and decisions
7. is aware of the temporal and social context of science and technology;
8. in addition to a recognisable domain-specific profile, possesses a sufficiently broad basis for interdisciplinary and multidisciplinary work.

A graduate of the MSc in Mechanical Engineering:

1. is qualified to degree level within the domain of 'science engineering and technology';
2. is competent in the relevant domain-specific discipline, i.e. Mechanical Engineering;
3. is able to conduct research and design independently;
4. has the ability and attitude to include other disciplines in his/her research, where necessary;
5. has a scientific approach to complex problems and ideas;
6. possesses intellectual skills that enable him/her to reflect critically, reason and form opinions;
7. is good at communicating the results of his/her learning, thinking and decision-making processes at international level;
8. is aware of the temporal and social context of science and technology (comprehension and analysis) and can integrate this in his/her scientific work;
9. in addition to a recognisable domain-specific profile, possesses a sufficiently broad basis to be able to work in an interdisciplinary and multidisciplinary context, the latter in the sense of being focused on other relevant disciplines needed to solve the design or research problem in question;
10. actively seeks new potential applications, taking into consideration the social context.

Appendix 4: Overview of the curricula

Bachelor programme 2011-2012

Quartile	Compulsory courses	DBL projects	DBL training blocks
1.1	Calculus Mechanics A bird's eye view on mechanical engineering	Pin-jointed structures	MARC Meeting skills Tools for design MatLab 1 Training CAD Safety and health
1.2	Linear algebra Introduction heat and flow Introduction electrical and mechanical drive systems	Power tools dissected A balance in motion	Basic mathematical skills MatLab 2 Design training Self-evaluation report Study management
1.3	Installations in process industry Dynamics Signal analysis	Sustainable manufacturing technology Rotating filter	Presentation skills Feedback and peer-review Group skills
1.4	Vector calculus Structure and properties of metals System analysis	Modeling of dynamical system Let's make music	Measurement technique
2.1	Material models Control engineering Engineering thermodynamics	'straight around the corner…' Printer head	MARC
2.2	Mechanical vibrations Polymers: structure and properties Analysis of manufacturing systems	The propeller	Training CAD/CAM
2.3	Physical transport phenomena Applied elasticity in engineering Design principles	Assembly line for lawn-mowers Design in polymer materials	MARC Training self-contemplation
2.4	Technology assessment Numerical methods Finite element method	Design of a central heating boiler CAD/FEM design	English support
3.1-2	Minor courses and projects		
3.3	Continuum mechanics for advanced manufacturing technologies Polymer processing Chemistry and transport in energy conversion processes	Programming project	
3.4	Heat transfer Micro-and nano-technology Applications of design principles BFP		

Bachelor programme 2012-2013

1.1	1.2	1.3	1.4
Basis wiskunde	Basis natuurwetenschappen	Basis Design	Basis USE
Mechanica	Dynamica	Signalen	Structuur en eigenschappen van materialen
Inleiding W/Vakwerkcasus	Keuzevak W: OGO Trebuchet	OGO: Propeller	Keuzevak W: OGO Werktuig op tafel
2.1	2.2	2.3	2.4
Basis Modelleren	Regelen van mechanische systemen	Stromingsleer	Materiaalgedrag en elasticiteitsleer
Thermodynamica	OGO AES: Buisenframe op tafel	OGO DSD: Robotarm	OGO TFE: Verbrandingsmotor
Keuze/USE	Keuze/USE	Keuze/USE	Keuze/USE
3.1	3.2	3.3	3.4
Numerieke methoden/EEM	Fabricagesystemen	Keuze	Keuze
OGO CEM: CAD/FEM	Constructieprincipes	Keuze	Keuze
Keuze/USE	Keuze/USE	Bachelor eindproject	Bachelor eindproject

Appendix 5: Quantitative data regarding the programmes

Data on intake, transfers and graduates

1. Bachelor Werktuigbouwkunde (56966). Cohortomvang en samenstelling bachelor (voltijdse instroom)

Jaar	Cohortomvang met vooropleidingscategorie					Totaal
	VWO	HBO prop	HBO*	Buitenland	Overig	
02/ 03	125	2	17	1	4	149
03/ 04	136	0	1	2	1	140
04/ 05	130	1	29	3	2	165
05/ 06	138	0	25	3	1	167
06/ 07	137	0	23	5	3	168
07/ 08	147	0	39	2	1	189
08/ 09	158	1	44	3	0	206
09/ 10	134	1	53	2	0	190

* HBO is inclusief de studenten die een schakelprogramma/premaster doen

2. Bachelor Werktuigbouwkunde (56966). Vertrek bachelorstudenten (alle vooropleidingen)

Cohort	Vertrek bachelorstudenten bij de opleiding					
	Omvang cohort	Na 1 jaar	Na 2 jaar	Na 3 jaar		Selectiviteit van 1e jaar
	Absoluut	Percentage (cumulatief), wordt niet vermeld als het toaal kleiner dan 4 is				
02/ 03	149	23	31	32		71
03/ 04	140	23	32	36		63
04/ 05	165	25	38	42		60
05/ 06	167	26	40	42		61
06/ 07	168	31	45	48		65
07/ 08	189	33	42	*45		*74
08/ 09	206	28	*40			
09/ 10	190	*37				

* voorlopige cijfers op peildatum 1-oktober

3. Bachelor Werktuigbouwkunde (56966). Bachelorrendement van herinschrijvers opleiding (Totale instroom)

Cohort	Omvang herinst.	% van het totale cohort	Bachelorrendement van herinschrijvers Na 3 jaar	na 4 jaar	na 5 jaar	na 6 jaar	> 6 jaar
	absoluut	**Percentage** (cumulatief), wordt niet vermeld als het totaal kleiner dan 4 is					
02/ 03	115	77	7	28	55	67	74
03/ 04	108	77	11	28	53	65	70
04/ 05	123	75	7	25	48	56	
05/ 06	124	74	15	31	50		
06/ 07	116	69	11	28			
07/ 08	126	67	11				
08/ 09	149	72					
09/ 10	120	63					

4. Master Mechanical Engineering (60439). Cohortomvang en onderwijsherkomst masterinstroom (voltijdse instroom)

Cohortomvang en onderwijs-herkomst masterinstroom					
Jaar	**Eigen universiteit**	**Andere universiteiten NL**	**HBO**	**Buiten HBO**	**Totaal**
03/ 04	2	0	0	1	3
04/ 05	197	1	10	10	218
05/ 06	178	3	8	6	195
06/ 07	148	1	11	10	170
07/ 08	92	1	2	6	101
08/ 09	96	3	1	9	109
09/ 10	92	0	4	8	104

5. Master Mechanical Engineering (60439). Studieduur masteropleiding naar Onderwijsherkomst (voltijdse instroom)

Eigen universiteit			**Andere universiteiten NL**		**HBO**		**Buiten HBO**	
Afstudeer Cohort	**Geslaagd Absoluut**	**Duur opl. gem.**	**Geslaagd Absoluut**	**Duur opl. gem.**	**Geslaagd absoluut**	**Duur opl. gem.**	**Geslaagd Absoluut**	**Duur opl. gem.**
		In mnd.		**In mnd.**		**In mnd.**		**In mnd.**
04/ 05	54	7						
05/ 06	66	17					3	25
06/ 07	79	24	1	36			2	28
07/ 08	112	31					1	26
08/ 09	111	35					6	26

Teacher-student ratio achieved

Year	Teaching effort	Students (1 Dec.)						Student/staff ratio	
	Staff (fte)	Number of registered students BSc and MSc						Total	BSc & MSc Mech. Eng.
		BSc Mech. Eng.	MSc Mech. Eng.	MSc SET	MSc S&C	MSC AT	Total		
2011	60.7	713	332	130	39	48	1262	20.7	17.2
2010	61.1	702	313	93	46	36	1190	19.5	16.7
2009	57.7	703	273	67	31	21	1095	18.9	16.9
2008	55.3	676	290	49	11	0	1026	18.6	17.5
2007	52.6	686	268	33	3	0	990	18.8	18.1

Average amount of face-to-face instruction per stage of the study programme

With lecturer						Without lecturer		
Programme	Lectures	Individual study under supervision	Practical training	Project etc.	Total	Individual study	Project	Total
BSc 1 60 EC	248 15%	154 9%	75 4%	114 7%	591 35%	654 39%	435 26%	1089 65%
BSc 2 60 EC	241 13%	141 8%	12 1%	128 28%	522 31%	646 39%	512 31%	1158 69%
BSc 3 21 EC	94 6%	56 3%	-	7 0,5%	157 9,5%	364 21,5%	67 4%	431 25,5%
Minor 30 EC	100 6%	56 3%	-	20 1%	176 10%	348 21%	316 19%	664 40%
BFP 9 EC	-	-	-	15 1%	15 1%	-	237 14%	237 14%
MSc 1	240 14%	120 7%	10 0,5%	20 1%	390 23%	890 53%	400 24%	1290 77%
MSc 2 Option 1*	80 5%	48 3%	5 0,3%	-	133 8%	287 17%	-	287 17%
MSc 2 Option 2*	-	-	-	-	-	420 25%	420 25%	420 25%
MSc thesis	-	-	-	45 3%	45 3%	-	1215 72%	1215 72%

* MSc 2 Option 1: Individual space filled with courses
* MSc 2 Option 2: Individual space filled with project work or a literature study

Appendix 6: Programme of the site visit

Dinsdag 25 september 2012 alle gesprekken vinden plaats in zaal Gemini Noord 1.02 tenzij anders aangegeven	
8.00	**Ontvangst commissie** (zaal Gemini Zuid 1.124)
8.30-9.30	**Management** Prof dr. L.P.H.(Philip) de Goey, decaan Dr. ir. H.C. (Rick) de Lange, opleidingsdirecteur Ir. S.H.P.A. (Suzanne), Jacobs, opleidingscoördinator Msc A. (Alexandra) Nicolaije, kwaliteitszorg
9.30-10.15	**Studenten** C. (Caroline) Balemans, 2008 CEM J. (Jasper) Beerens, 2007 CEM A.L. (Anna) van Velsen, 2008 DSD N.C.J. (Noud) Maes, hbo-instromer masterfase J.J.M. (Jules) Frints, 2010 bachelorfase J.T. (Joost) Lammers, 2011 bachelorfase
10.15-11.00	**Docenten** Dr.ir. M.J.G. (René) van de Molengraft, DSD Dr.ir. L.F.P. (Pascal) Etman, DSD Prof.dr. J.G.M. (Hans) Kuerten, TFE Dr.ir. L.M.T. (Bart) Somers, TFE Dr.ir. R.H.J. (Ron) Peerlings, CEM Dr.ir. J.J.C. (Joris) Remmers, CEM
11.00-11.45	**Opleidingscommissie** R.P.A. (Rianne) Gommans, student namens Simon Stevin F.J. (Frank) Aangenendt, student M.M.G. (Max) van Lith, student Prof.dr.ir. E.H. (Harald) van Brummelen, voorzitter Prof.dr.ir. M. (Maarten) Steinbuch, staf Dr.ir. J.A.W. (Hans) van Dommelen, staf
11.45-12.00	**Bezoek faciliteiten in 2 groepen**
12.00-12.45	**Lunch** (zaal Gemini Zuid 1.124)
12.45-13.30	**Examencommissie en studieadviseur** Prof.dr.ir. A.A. (Anton) van Steenhoven, voorzitter Dr. B.P.M. (Bart) van Esch Dr.ir. N. (Nathan) van de Wouw Dr.ir. M.A. (Martien) Hulsen Drs. T.M.C. (Tanja) Krijgh, studieadviseur S.M. (Suzanne) van den Bergh-Leegte, studieadviseur

13.30-14.00	**Alumni** T.A.P. (Tom) Engels, DSM B.F.W. (Nard) Vermeltvoort, Alliander B.A.G. (Bart) Genuit, TU/e H.H. (Harm) Clements, PRECEYES Medical Robotics J.W.E. (Jorine) Heling, Vander Landen
14.00-14.30	**Voorbereiding eindgesprek en open spreekuur** (zaal Gemini Zuid 1.124)
14.30-15.30	**Eindgesprek met management** Prof dr. L.P.H.(Philip) de Goey, decaan Dr. ir. H.C. (Rick) de Lange, opleidingsdirecteur Ir. S.H.P.A. (Suzanne), Jacobs, opleidingscoordinator Msc. A. (Alexandra) Nicolaije, kwaliteitszorg
15.30-17.30	**Opstellen bevindingen**
17.30-18.00	**Mondelinge rapportage en afsluiting**

Appendix 7: Theses and documents studied by the committee

Prior to the site visit, the committee studied the theses of the students with the following student numbers:

Bachelor final project:

0655926	0651245	0653102
0617173	0655090	0658173
0616995	0657631	0658013
0591943	0668301	0657182
0650623	0660668	0650545

Master theses:

0594064	0666146	0592046
0578827	0568202	0567715
0478151	0508243	0595313
0528619	0570553	0569237
0557354	0573604	0548585

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

Course materials for courses and projects:
- Course outlines
- Assignments
- Answers and assignment papers by students
- Evaluation forms

Quantitative data on student intake and output

Education Committee:
- Minutes of 2011-2012 meetings
- Annual educational reports
- Curriculum evaluations

Board of Examiners:
- Minutes of 2011-2012 meetings
- Letters and communications to staff

Task force re-design bachelor programme:
- Minutes of 2011-2012 meetings

Appendix 8: Declarations of independence

nvao
nederlands - vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: JORIS DE SCHUTTER

PRIVÉ ADRES: TR. VAN RYSWYCKLAAN 1
B-2850 BOOM
BELGIE

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

WERKTUIGBOUWKUNDE

AANGEVRAAGD DOOR DE INSTELLING:

TU Delft, TU Eindhoven
Universiteit Twente

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

nvao
nederlands - vlaamse accreditatieorganisatie

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Boom DATUM: 2 september 2012

HANDTEKENING:

2

nvao
nederlands - vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: G. CALIS

PRIVÉ ADRES: Plasweg 50
3768 AN SOEST

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Werktuigbouwkunde (en Maritieme Techniek)
aan TUD, TUE en UT

AANGEVRAAGD DOOR DE INSTELLING:

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

nvao
nederlands - vlaamse accreditatieorganisatie

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Rotterdam DATUM: 4 sept. 2012

HANDTEKENING:

2

nvao
nederlands - vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: J.J. ter Meulen

PRIVÉ ADRES: Van Peltlaan 271
6533 ZH Nijmegen

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Werktuigbouwkunde

AANGEVRAAGD DOOR DE INSTELLING:

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

nvao
nederlands - vlaamse accreditatieorganisatie

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Nijmegen DATUM: 4-9-2012

HANDTEKENING: [illegible]

2

nvao
nederlands - vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: ir H. Grunefeld

PRIVÉ ADRES:

Wevelaan 55
3571 XS Utrecht

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

werktuigbouwkunde, maritieme techn. TUD
werktuigbouwkunde TUE

AANGEVRAAGD DOOR DE INSTELLING:

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

nvao
nederlands - vlaamse accreditatieorganisatie

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Rotterdam

DATUM: 4 september 2012

HANDTEKENING: H. Grunefeld

2

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: ~~Spoorsingel 92~~ Thomas Oftraus

PRIVÉ ADRES: Spoorsingel 92, 2613 BC Delft

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Werktuigbouwkunde

AANGEVRAAGD DOOR DE INSTELLING:

TU Eindhoven

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Delft DATUM: 03-09-2012

HANDTEKENING:

2

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: Marianne van der Weiden

PRIVÉ ADRES: Homeruslaan 62
3581 MJ Utrecht

IS ALS DE~~SKUNDIGE~~ / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Werktuigbouwkunde

AANGEVRAAGD DOOR DE INSTELLING:

TUD, UT, TUE

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Utrecht DATUM: 4-9-2012

HANDTEKENING:

2