HAN University of Applied Sciences

Master Engineering Systems

Limited Study Programme Assessment

006A2019.08
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Summary

In November 2019 the professional Master Engineering Systems at the HAN University of Applied Science (HAN) was visited by an NQA audit panel. This is a two-year full-time and part-time programme in Arnhem, taught in English. The panel assesses the quality of the full-time and part-time study programme as **positive.**

Standard 1: Intended learning outcomes

The full-time and the part-time study programme **meet** the generic quality on standard 1. The programme aims to teach students how to apply relevant knowledge and techniques from fundamental research in industrial environments all over the world. Graduates can analyse and adjust complex technical processes in order to work with advanced engineering systems. The programme offers a double degree in cooperation with the Czech Technical University, ENSTA Bretagne and the Technische Universität Chemnitz for the track Automotive systems ('MAE'). The double degree offers students an interesting experience abroad. The study programme has a clear profile on the level of a professional master, that is appreciated by the professional field. In being a unique applied sciences programme, it makes it necessary to keep on specifying the profile of the study programme towards the professional field. This can be done by intensifying conversations with research universities and the working field.
The intended learning outcomes give an adequate, competence-based description of the master level. They tie in with requirements currently set by the international professional field and relevant disciplines with regard to the contents. There is a strong connection between the programme and the professional field and research field. The programme safeguards the actuality and relevancy of the profile through regular consults with the master advisory committee and various lectorates at the HAN.

Standard 2: Teaching-learning environment

The full-time and the part-time study programme **meet** the generic quality on standard 2. This professional master programme offers practice-oriented theory on a good academic level. The programme is international and English-taught, because the professional field is mainly internationally orientated. The programme has a firm, transparent and up to date curriculum with a good balance between theory and practice. For every module there are clear educational objectives formulated, that are based on the intended learning outcomes. Every theoretical part within a module is logically sequenced by applying knowledge within exercises and a minor project. The innovative teaching methods activate students, for example through the flipped-classroom model. Students receive excellent, personal and accessible guidance during their studies. Student guidance is extra important in this study programme, since the programme attracts students from all over the world. Students have different backgrounds and are mostly not used to the Dutch way of studying. The panel is impressed by the approaches the lecturers and programme management have taken on to deal with these kinds of challenges.
Lecturers have the necessary expertise on content and didactics and show great commitment to this programme. They have a good command of the English language, written as well as oral. Because four out of the five specialisation tracks are coordinated by a professor ('lector'), the education is strongly connected to research projects and actual demands from the working field.

Students need laboratories to execute research projects and the use of laboratories is well integrated in the teaching methods. The laboratories are equipped sufficiently.

Standard 3: Student assessment

The full-time and the part-time study programme **meet** the generic quality on standard 3. The programme has a transparent system of assessment that follows the structure of the modules (see standard 2) logically. The assessment system is based on the idea of assessing through assignments in authentic professional settings. In line with this principle, high level theory related exams build up logically towards the minor projects, in which theory is indeed brought into practice in realistic professional settings on a convincing master level. The assessment forms for the minor projects are recently levelled up with the major project, which contributes further to the transparency of the assessment system.
The quality of assessments is safeguarded sufficiently. The exam board has a realistic picture of the quality of the assessment system and safeguards the level and the quality of examination according to legislation. The panel means that the exam board can carry out their advices even stronger to stimulate quality improvement even more. For the double degree there are clear and adequate regulations in place, that haven been -among others- written down in the *Degree Statute*. The quality assurance of assessment can be further improved on two points. First of all, there are questions in the written exams that are multi-interpretable, and some seem to require standard answers that students can memorize. It is advisable to pay attention to the construction of questions in the written exams to make the questions more unambiguously and flexible. Increasing the number of BEQ certified examiners could positively contribute to this point of improvement.

Standard 4: Achieved learning outcomes

The full-time and the part-time study programme **meet** the generic quality on standard 4. Graduates achieve all learning outcomes during the programme and add good value to the international professional field and research field. They are valuable for the professional field because they possess a unique combination of knowledge on complex systems modelling and the ability to apply this knowledge in different practical contexts.
The end level is assessed in the minor projects (5 EC per module) as well in a final major project that leads to innovation in professional practice (30 EC). The major projects show a variety of quality, ranging from excellent reports to reports on an average or minimal level. Grading by examiners matches this variety. Written feedback on the assessment forms can still be improved. In general, the major projects show relevant subjects, good mathematical modelling, meaningful use of IT-models and good reporting skills. The high level of this study programme could be extended to the graduation phase by increasing the level of the major projects. The recent improvements in the assessment procedures for the minor and major projects offer good opportunities and expectations to realize this. Other suggestions are to give more attention to the relationship between theory and practice, and the consideration to differentiate the weighting of the learning outcomes in the assessment of the minor and major projects.

Contents

Introduction

This is the assessment report of the existing professional Master Engineering Systems at HAN University of Applied Sciences (HAN) in Arnhem. The assessment was conducted by an audit panel compiled by Netherlands Quality Agency (NQA) and commissioned by the HAN. Prior to the assessment process the audit panel has been approved by the NVAO.

In this report the audit panel gives account of its findings, considerations and conclusions. The assessment was undertaken according to the *Assessment framework for the higher education accreditation system of the Netherlands* of the NVAO (September 2018) and the *NQA Guideline 2019 for a limited programme assessment*.

The site visit took place on 28 and 29 November 2019. The audit panel consisted of:
Mr ir. I.F. van der Meer (chairman, domain expert)
Mr D.J. de Cloe MSc, MBA (domain expert)
Mr ir. J. Wijkniet (domain expert)
Mr prof. dr. ir. B. Jayawardhana (domain expert)
Mr ing. S.R.R. Boonstra (student member)

Ms drs. M. Schoots, NQA-auditor, acted as secretary of the panel.

The study programme is part of the visitation group ‘HBO Automotive’. Panel members received an instruction regarding the Assessment Framework. The assessment criteria calibrated between Hobéon and NQA are part of this instruction. Next to this, alignment between sub-panels is guaranteed by experts being a member in several sub-panels. In addition, taking into account that each programme assessment is an individual assessment, panel members reflected on previous visits within this visitation group. This visitation was a two-day site visit for both the Master Engineering Systems and the Bachelor Automotive of the HAN. The reason for this combination is the overlap in partners from the professional field and lecturers for the largest track of the master programme: Automotive systems. Except for Mr Javawardhana, the panel members also functioned for the assessment of the Bachelor Automotive programme.

The study programme offered a self-evaluation report that was according to the requirements of the NVAO framework. The audit panel studied the self-evaluation report and appendices. During a preliminary panel consultation, the site visit was prepared, and panel members were instructed on the NQA working method and the NVAO framework. Preliminary findings were discussed during the preliminary consultation.

During the site visit, the panel has spoken with various stakeholders of the programme, such as students, alumni, lecturers and representatives from the professional field. Staff members and students of the study programme were given the opportunity to approach the panel (via e-mail), in addition to the site visit. No staff member or student used this opportunity to approach the panel. The panel studied the additional material related to the study programme during the site visit (see Appendix 2). The self-evaluation and all other (oral and written) information have enabled the panel to reach a deliberate judgement. At the end of the site visit, the audit panel formulated a preliminary assessment with substantiation. During the final feedback session, the chair of the

panel communicated the preliminary assessment and important findings to the representatives of the study programme.

After the site visit the secretary wrote a concept report, on base of the information and opinions of the panel members. The panel members gave feedback on the concept report, and the panel asked for some more specific information about the double degree. The study programme delivered the extra information and the panel has studied the documents about the double degree. With this information the findings of the panel for the double degree were completed and a second concept report was prepared. The second concept report was presented to the representatives of the study programme, whom reacted on factual inaccuracies. The panel members have seen the reaction of the study programme and adjusted the report where necessary. After that, the final advisory report was prepared.

The panel declares the assessment of the study programme was carried out independently.

Utrecht, February 13, 2020

Panel chairman

Mr ir. I.F. van der Meer

Panel secretary

Ms drs. M. Schoots

Administrative data

Name study programme as in CROHO	Master Engineering Systems
Orientation and level study programme	Professional master
Variations	Full-time and part-time
Degree	Master of Science
Credits	90 EC
Graduation courses: ‘tracks’	Automotive systems Control systems Embedded systems Lean engineering Sustainable energy
Location	Arnhem
Language	English
Registration number in CROHO	49136
Financial status	Funded since 2016
Cluster	HBO Automotive
Date of return	01-05-2020
Double degree (track Automotive systems)	Czech Technical University, ENSTA Bretagne and the Technische Universität Chemnitz

Outline of the study programme

The study programme Master of Science Engineering Systems is a unique programme in the Netherlands with an applied science based curriculum. Due to the obtained funding in 2016 the programme has known a period of growth in students and staff members. The curriculum educates towards an international working field, the programme is taught in English and students come from all over the world. The programme contains 90 EC and takes 18 months for a full-time student and 2,5 to 3 years for a part-time student. The difference between the full-time programme and the part-time programme is that full-time students follow two modules at the same time per semester and part-time students follow one module per semester. Full-time and part-time students are in combined groups and are offered the same curriculum.
The programme is placed within the Faculty of Engineering at the HAN University of Applied Science in Arnhem. Other programmes within this Faculty are the bachelor programmes 'Electrotechniek', 'Technische bedrijfskunde', 'Industrieel Product Ontwerpen' and 'Werktuigbouwkunde', as well as three associate degree programmes. As the HAN is in a reorganization process, the programme will be placed in a new organizational unit as of January 2020: Academie Engineering & Automotive. This academy combines education and research within the same organizational unit.

The professional Master Engineering Systems originates from two previously offered master programmes of the HAN: the Master Automotive Systems and the Master Control Systems Engineering. The merge of these two programmes was a planning-neutral conversion (letter NVAO 12 October 2017), and is in line with the national policy to reduce the number of technical programmes and objected to create more transparency in the overall spectrum of programmes. The merger was a fact in September 2018.
The master programme starts with two common modules and proceeds with two modules in one of five specialisation tracks, of which two are directly derived from the two previous master programmes. This is in line with the planning-neutral conversion. The programme has around 278 students of which the vast majority has chosen the track Automotive systems (171 students). The track Control systems has 41 students at the time of the site visit, the track Embedded systems 17, Lean engineering 14 and sustainable energy 34. In the schedule on the next page the study programme is shown schematically.

The Master Control Systems Engineering was assessed as 'good' in the last accreditation that took place in January 2015. For example, the panel was explicitly positive about the intended learning outcomes, the use of feedback of experts to keep the programme up to date, the staff expertise and the level of the major projects. Points for improvement were the student self-dependence, the involvement of the central exam board, quality of the given feedback and the references to scientific sources.
The Master of Automotive Systems was assessed as 'satisfactory' in the last accreditation that took place in December 2014. Then, the panel was for example positive about final qualifications, the international orientation, the staff quality, the student guidance and the decent assessment system. Points for improvement were reporting skills, attention for maths and electronics and proper use of scientific sources.

Curriculum overview

Common mandatory modules:
Systems modelling (15 EC)
Applied control (15 EC)

Track choice (2x 15 EC)

Automotive systems (Joint degree possible):
Module Advanced Vehicle Dynamics
Module Electric Hybrid Fuel Cells Powertrains
Module Big Data and Small Data
Module Sustainable Fuel Engines and Emissions
Module Smart Infrastructure
Module Smart Vehicles
or
Control systems:
Module Big Data and Small Data
Module Advanced Controller Design
or
Embedded systems:
Module Distributed Systems
Module Big Data and Small Data
or
Lean engineering:
Module Process Development
Module Product Development
Module Big Data and Small Data
or
Sustainable energy:
Module Sustainable Energy Systems
Module Big Data and Small Data
Module Smart Power Supplies

Major project (30 EC)

Standard 1 Intended learning outcomes

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

Conclusion

The full-time and the part-time study programme **meet** the generic quality on standard 1. The programme aims to teach students how to apply relevant knowledge and techniques from fundamental research in industrial environments all over the world. Graduates can analyse and adjust complex technical processes in order to work with advanced engineering systems. The programme offers a double degree in cooperation with the Czech Technical University, ENSTA Bretagne and the Technische Universität Chemnitz for the track Automotive systems. The double degree offers students an interesting experience abroad. The panel concludes that the study programme has a clear profile on the level of a professional master, that is appreciated by the professional field. In being a unique, applied sciences programme, it makes it necessary to keep on specifying the profile of the study programme towards the professional field. This can be done by intensifying conversations with research universities and the working field.
The intended learning outcomes give an adequate, competence-based description of the master level. They tie in with requirements currently set by the international professional field and relevant disciplines with regard to the contents. There is a strong connection between the programme and the working field and research field. The programme safeguards the actuality and relevancy of the profile through regular consults with the master advisory committee and various lectorates at the HAN.

Findings and considerations

Professional profile
The subject of engineering systems is mostly dealt with at research universities. The Master of science Engineering Systems at the HAN consciously aims to work from the principle of applied sciences. This means that students learn to apply knowledge and techniques from fundamental research in order to solve complex, practice-related problems. The programme believes that the practical orientation creates an added value for the international working field. Graduates can design, develop, improve, use and maintain advanced technical engineering systems. The programme encompasses all stages and all aspects of the life cycle of a system: the technical content, the working methods and the business processes. This means that the focus of the curriculum is on system thinking. This system thinking can be applied in a broad range of contexts: for example, automotive, logistics or factory processes. Furthermore, the programme means to educate students to work in any international environment: from international companies established in the Netherlands to local companies all over the world.

Educational profile
The study programme has specifically developed a set of learning outcomes for this unique master programme. The learning outcomes are: (1) Analyzing and defining problems, (2) Design, (3) Testing, (4) Managing work processes, (5) Conducting research, (6) Communication and

collaboration and (7) Professional development. The panel believes that the learning outcomes give an adequate, general, competence-based description of the aimed end level. The learning outcomes are formulated on master level with a clear professional orientation and tie in with requirements currently set by the international professional field and relevant disciplines with regard to the contents. The learning outcomes are directly linked to the Dublin descriptors on the master level, which is also clearly reflected in the assessment forms (see standard 3 and 4).

The intended learning outcomes of the Master Engineering Systems are directly derived from the intended learning outcomes from the former Master Control Systems Engineering and the former Master of Automotive Systems, which is in line with the planning-neutral conversion. These former learning outcomes were developed on the base of an analysis of international professional profiles, the master programmes of other universities and international employment advertisements. For the new programme Master Engineering Systems, the former learning outcomes were merged and further developed in cooperation with the master advisory committee of the programme. The panel has seen that this committee consists of members that represent all relevant international contexts in which system engineering is applied. There are for example members from companies such as DAF and HyMatters, and from other professional universities. During the site visit the panel has seen that the study programme holds strong connections with their master advisory committee and there are frequent consultations. The professors (‘lectoren’) involved in the programme (see standard 2) also play an important role in keeping the learning outcomes up to date. The panel concludes that the programme has a strong safeguarding system to keep the profile and the curriculum actual and relevant for the international professional field and the research field.

Double degree
Students who follow the graduation track Automotive systems can apply for a double degree: (1) European Master of Automotive Engineering (‘MAE’: together with Czech Technical University, ENSTA Bretagne and the Technische Universität Chemnitz) and (2) Master of Science (HAN). If students want to apply for the double degree, they start their studies abroad. Around 15 to 20 students per year participate in the double degree programme. See standard 3 for regulations and procedures.
The modules in Prague were developed in a cooperation between the HAN and the Czech Technical University and are taught by lecturers from the Czech Technical University and lecturers of the HAN. The modules in Germany and France are developed by the concerning universities. At the time of the site visit 18 HAN-students (6,5 percent of the students in the track Automotive systems) were in the MAE programme. Students that the panel has spoken to experience the double degree as an advantage on the European job market. The panel sees the advantage for students, who can experience part of their studies abroad.

Specific profile
This programme is unique due to the applied science approach of a normally only research orientated content. The programme clearly offers an added value to the working field according to the panel. The panel sees this reflected in the positive reaction of the professional field and the experiences of graduates. Furthermore, the international character and working field makes this programme even more unique according to the panel.
It appears that professors and students from master programmes in engineering from research-oriented universities, aim for the same type of (research) projects in the professional field. The

programme representatives talked openly to the panel about discussions with representatives from research universities about this. The panel means that this is a result of a general shift within the bachelor-master system. To maintain a clear specific profile towards the professional field, the panel recommends intensifying conversations with research universities and the working field in order to keep their own profile specified in relation to other master programmes. Furthermore, the study programme could communicate more clearly about the unique characteristics of their applied sciences programme.

Standard 2 Teaching-learning environment

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

Conclusion

The full-time and the part-time study programme **meet** the generic quality on standard 2. This professional master programme offers practice-oriented theory on a good academic level. The programme is international and English-taught, because the professional field is mainly internationally orientated. The programme has a firm, transparent and up to date curriculum with a good balance between theory and practice. For every module there are clear educational objectives formulated, that are based on the intended learning outcomes. Every theoretical part within a module is logically sequenced by applying knowledge within exercises and a minor project. The innovative teaching methods activate students, for example through the flipped-classroom model. Students receive excellent, personal and accessible guidance during their studies. Student guidance is extra important in this study programme, since the programme attracts students from all over the world. Students have different backgrounds and are mostly not used to the Dutch way of studying. The panel is impressed by the approaches the lecturers and programme management have taken on to deal with these kinds of challenges.
Lecturers have the necessary expertise on content and didactics and show great commitment to this programme. They have a good command of the English language, written as well as oral. Because four out of the five specialisation tracks are coordinated by a professor (‘lector’), the education is strongly connected to research projects and actual demands from the working field. Students need laboratories to execute research projects and the panel sees that the use of laboratories is well integrated in the teaching methods. The laboratories are equipped sufficiently.

Findings and considerations

Curriculum
The programme has formulated clear educational objectives, that are derived from the intended learning outcomes. The educational objectives are mainly presented in the online learning environment together with other relevant module information.

The panel sees a unique professional master programme that offers theory on a high level. Electronics, math, IT and business are the core contents of this programme. Per specialisation track these subjects are placed in a different practical context. The curriculum is firm and up to date and offers diverse actual content in adequate literature and readers. Every module consists of theory (7,5 EC), capita selecta (2,5 EC) and a minor project (5,0 EC). Knowledge and understanding are relatively important in this professional master programme, due to the technical and mathematical knowledge that is necessary to work on engineering systems. Knowledge is according to the panel offered on a high level in theoretical lectures and in the capita selecta.

After the theoretical parts, students apply knowledge in practical (research) exercises and the minor projects. The minor projects are mostly based on a casus and consist of applying

knowledge in research orientated assignments. Assignments are for example building a truck that can be controlled by an IT-application or designing a logistic mechanism to control the parking of sea containers. The programme also offers guest lectures on actual themes regularly. Most guest lectures are organised by professors from lectorates. Students are pleased with the logical sequence of knowledge and practice and appreciate the guest lectures. A point of attention concerning practical skills that was mentioned by representatives of the professional field is presentation skills, which can be developed more with mainly foreign students. The programme explained that there is attention for this skill, but it is a challenge due to cultural differences in terms of what a good presentation beholds.

Five specialisation tracks
The curriculum starts with two mandatory modules of 15 EC that give students a good basis in knowledge and understanding according to the panel. After the two basic modules, students choose one of five graduation courses ('tracks'): Automotive systems, Control systems, Embedded systems, Lean engineering or Sustainable energy. Students tell the panel that they are well equipped after the first two modules to start one of the tracks. Students feel well guided for their choice of a track. The panel confirms that all five tracks are distinctive and valuable for the professional field. The five tracks cover the different industries of engineering systems well.

International orientation
The professional field that matches the study programme, is international in its core because of the international orientation of the companies that students are employed after graduation. The study programme attracts students from all over the world. Students work together in project groups and learn from each other about different professional norms and values in a large variety of countries. This mixture of cultural backgrounds and the international orientation of the professional field make the study programme international and English-taught in a natural way.

The study programme has a variety of strong international cooperations with foreign universities. Within these cooperations lecturers are exchanged, knowledge is built together and (Dutch) students have the opportunity to experience international environments during their studies. The opportunity for exchange is used by several students each year, and multiple lecturers are regularly active with foreign universities. The programme works together with the Czech Technical University, Chemnitz Technical University and ENSTA for a double degree (see standard 1). The study programme also has several other contacts with universities abroad. These are for example Chalmers University of Technology (Sweden), Thomas More College (Belgium) and University of applied sciences Kleve (Germany).

Admission and inflow
The admission criteria are conforming legal demands: a proved bachelor level. Following the government funding of the programme that was obtained in 2016, the number of students increased fundamentally over the past years. The vast majority of the students is foreign. At this moment almost half of the students is Asian. Other nationalities represented in the student population are for example Mexicans, Romanians, Czechs, French, Bulgars and Dutch.

The panel has seen that lecturers are very well aware of the challenges that this great diversity of national backgrounds brings. Students have different knowledge at the start of the programme and are mostly not used to the Dutch way of studying. Furthermore, part-time students are mostly

already employed in the working field and have different experiences in comparison with full-time students. The panel is impressed by the professional way lecturers and programme management discuss these kinds of challenges and act on the needs of students. Students feel well guided into the Dutch system and are being taught typical Dutch skills, like questioning in a direct way. Lecturers guide foreign students for example in how to give and receive feedback, working together and how to self-direct your own study path. The programme also offers free classes in Dutch language for foreign students. Foreign students even learn how to apply for jobs in the Netherlands and how to deal with interpersonal difficulties within a working situation in the Netherlands. The HAN International Office offers support to students for housing and other practical matters. Students tell the panel that it is a great extra value to be in the classroom with such a diversity of students.

An example of the good guidance at the start of the programme is that all candidate students receive a preliminary mathematics course: 'Mathematics 0'. This course is meant to verify and upgrade mathematical skills and level the expectations about the programme. Almost all candidate students follow this course.

Research
The programme aims to work in the triangle of professional practice, research community and education community. The panel has seen that the study programme succeeds in this ambition. The study programme is well connected to actual research because four out of five specialisation tracks are being led by a professor ('lector'). Because of this model contents of the study programme are developed by lecturers and professors together, professors function as lecturer and actual research themes and education are logically connected. Professors participate in various committees such as the program board, the program committee and the major project board. Students participate regularly in research projects of lectorates for the major project. Examples of such projects are the development of a control system for parking trucks in a logistic centre or an advanced control system for a diesel motor.

The professors have strong connections with the professional field through executing research projects for companies. They have contacts with guest lecturers and offer a broad variety of examples of applied research projects to students.

Research centre	Involvement in study programme
HAN Automotive research	Professor is coordinator of the track Automotive systems
HAN Control systems	Professor is coordinator of the track Control systems
HAN Lean and world class performance	Professor is coordinator of the track Lean engineering
HAN Sustainable energy	Professor is coordinator of the track Sustainable energy

There is also a fair number of lecturers involved in the research projects of the lectorates. They are involved in research projects about sustainable energy, autonomous driving, smart infrastructure, green mobility, smart mobility, alternative fuels and hydrogen technology. The panel has seen that the students benefit from this because examples from research practice are being used in lectures. The panel has also seen that actual research that is published outside the HAN is used in the classroom. For example, a research project about the logistics of road safety, that was derived from the news and analysed by students.

Students learn adequate research skills through theory and exercises about different methodological approaches. The panel determines that students are reached diverse research methods and that students are able to use different types research methods adequately in the minor projects and the major project. A specific didactical form that the panel applauds is the game *Engineering Methods Pack*. The HAN has transformed a generic version of this game into a specific game to teach research skills in engineering contexts. The game teaches students a diversity of research skills that suit different research questions.

Educational approach and student guidance
Students receive excellent guidance during their studies according to the panel. The guidance is personal and meets the different needs of the diverse student population well (see Admission and inflow). Students are of the opinion that lecturers are experienced, accessible and helpful. Lecturers use activating and innovative didactical forms, such as the flipped-classroom model. Students tell the panel that lecturers function as coaches and activate students towards self-guidance. Nevertheless, lecturers continue their conversations about activating didactical forms because of the challenges at this point for foreign students. Most Asian students for example are not used to asking questions and being critical. The panel has seen that the lecturers show that they are constantly monitoring development processes like this and trying to improve didactical methods.

Staff quality
The panel sees a greatly committed and driven team of lecturers, that executes this international programme very well. The programme is in a dynamic phase, due to the increase of inflow and the expansion of staff members following this development. The team of lecturers consists of 58 lecturers that are mostly part-time connected to the study programme, next to research tasks or jobs in the professional field. Almost 100 percent of the lecturers has a master's degree and 41 percent has a PhD. Students are very enthusiastic about the knowledge, practical experience and didactical skills of the lecturers. Lecturers have a good command of the English language, written as well as oral. 21 percent of the lecturers is a native speaker in English and 19 percent origin from abroad, which gives them a head-start in guiding international students. Other lecturers also have good skills in English, proven in for example IELTS certificates, Cambridge certificates B2 or Level C1 certificate. Students are satisfied about the level of English spoken and written by lecturers and the panel judges the level of the English language with lecturers as good.

Facilities
The programme uses laboratory facilities to let students execute their minor and major projects. In addition, control and simulation software are important for this programme. The programme offers students sufficient means in software, such as LabView for real-time measurement and control implementations, and Matlab for simulations, data manipulation and calculations. The panel has seen these facilities and had several demonstrations of the facilities in these laboratories. The laboratories are sufficiently equipped, and the use of the laboratory facilities is well integrated in the teaching methods according to the panel. All students use the facilities as a logical part of the study programme. The software is sufficient for the purpose of the programme. Students have direct access to scientific literature and lecture in the databases of Elsevier and Springer. Students tell the panel that these sources are not always sufficient and that they can order papers in these cases from other publishers at the library, at the programme's expense.

The panel believes that in a study programme where scientific knowledge is as important as it is in this programme, it would be advisable to make sure that students have more direct access to scientific literature of all publishers.

Standard 3 Student assessment

The programme has an adequate system of student assessment in place.

Conclusion

The full-time and the part-time study programme **meet** the generic quality on standard 3. The programme has a transparent system of assessment that follows the structure of the modules (see standard 2) logically. The assessment system is based on the idea of assessing through assignments in authentic professional settings. In line with this principle, high level theory related exams build up logically towards the minor projects, in which theory is indeed brought into practice in realistic professional settings on a convincing master level. The assessment forms for the minor projects are recently levelled up with the major project, which contributes further to the transparency of the assessment system.
The quality of assessments is safeguarded sufficiently. The exam board has a realistic picture of the quality of the assessment system and safeguards the level and the quality of examination according to legislation. The panel means that the exam board can carry out their advices even stronger to stimulate quality improvement even more. For the double degree there are clear and adequate regulations in place, that haven been -among others- written down in the *Degree Statute*. The assurance can be further improved on two points. First of all, there are questions in the written exams that are multi-interpretable, and some seem to require standard answers that students can memorize. Therefore, the panel advices to pay attention to the construction of questions in the written exams to make the questions more unambiguously and more flexible. Increasing the number of BEQ certified examiners could positively contribute to this point of improvement.

Findings and considerations

Assessment system
The assessment system is based on the idea of assessing through assignments in authentic professional settings. Assessment should furthermore give direction to the learning process and stimulate the learning behaviour of students in a positive way. This vision is recorded in the *Toetsbeleid technische masters* (2019). For students and lecturers, the assessment system is explained in English in the document *Assessment why and how for students and lecturers* (2014). In every module there are three types of exams, linked to the three parts that a module consists of (see standard 2). Theory is assessed in written or oral exams, Capita selecta in papers and the minor projects with a written report and an oral presentation. Students feel that this is a clear exam structure and information about the exams is well communicated in the online learning environment. The panel also believes that the clear and logical construction of the assessment system stimulates the learning process of students well. The only critics the panel heard of students is that students would prefer to have a possibility to take their re-exams faster after the first exam chance.

Examination
Written exams are constructed by two examiners, which meets the criteria of the four-eyes-principle. The programme calls this ‘peer review’ and this was implemented on advice of the

exam board. The peer review consists of a meeting between two examiners that talk through and improve the developed written exam. The panel has studied a selection of written exams, papers and minor projects including matching assessment forms. The panel concludes on base of this study that these exams are on the master level and connect well to the professional practice. The panel sees that students need a firm theoretical base to be able to execute the projects. The exams and papers assess the theoretical part on a high level, so students are well prepared for applying knowledge in the projects. In the minor projects, students bring theory into practice in realistic professional settings and apply knowledge on a convincing master level.

A remark of the panel is that the panel has seen several questions in the written exams that are multi-interpretable, and some seem to require standard answers that students can memorize. Further on, in some exams students need to memorize specific variables, such as formula and standard answers. The panel advices to pay attention during development and the peer reviewing to the construction of questions in the written exams, to make them more unambiguously and more flexible.

Assessment
The panel sees adequate assessment forms and confirms that assessment criteria are useful. There has been a recent improvement in the assessment forms of the minor projects. For older cohorts the panel found it difficult to match the assessment criteria to the learning outcomes. Recently all assessment forms for the minor projects were structured by the Dublin descriptors, in the same way that this was already done for the major project. The intended learning outcomes are now directly placed under the Dublin descriptors on all assessment forms. The panel feels that the levelling of the assessment forms for minor projects and the major project is a positive development that increases the validity of the project assessments. Furthermore, it makes it more transparent how students develop their competences during their studies. Thereby students tell the panel that this assessment system is very transparent to them. Because of this system, students are now very much aware of the intended learning outcomes and what is expected of them in the graduation phase. The coherent assessment system also supports assessment that is independent of the learning path, which is something the study programme would like to offer, for example to part-time students that have working experience. Very few students use this opportunity at the moment.

Minor projects are executed in a group of students. The panel has seen on the assessment forms that students are individually assessed for their contribution to the projects and are given individual feedback on their part of the project work.

Quality assurance
The programme bounded exam board safeguards the level and the quality of examination according to legislation. The exam board does this for example by appointing examiners, responding to requests for exemptions, analysing samples of exams and issuing certificates and diplomas. The board consists of three internal members, one external member and a secretary. The exam board acts independently of the management and advices the management in a monthly meeting. The panel has established that the exam board has a clear picture of the quality of the assessment and have advised the management on the rights issues. In advising examiners and the programme management, the panel feels that the exam board can carry out their opinion and advices stronger to stimulate quality improvement in assessment even more. For example,

the panel talked to the exam board about the possible compensation of partial grades within the major project (see standard 4). The exam board has advised earlier that this was not an ideal situation, but the decision of the programme management came only recently.

Examiners are supported by courses in Basic Examining Qualification (BEQ) and 22 percent of the examiners holds this qualification. 7 percent of the examiners hold the Senior Examining Qualification (SEQ). The exam board has noted in the *Jaarverslag van de examencommissie 2018-2019* that the number of BEQ certified examiners is still limited. The panel subscribes this point and encourages the study programme to get more examiners BEQ certified and the exam board to closely monitor progress on this point.

Double degree
The programme offers a double degree in cooperation with three partner universities (see standard 1). At the site visit the panel has seen the regulations for the double degree in the Degree Statute of HAN for this master programme. The panel has seen several other documents after the site visit that have regulations written down for students, the exam board and the three involved partners. Regulations for admission and exemptions are clearly and adequately formulated in these documents and complied with in practice and are according to Dutch legislation. Students need to successfully complete a two-year full-time programme: one year abroad in the Czech Republic, Germany and/or France, and one year in the Netherlands. The modules from abroad can be submitted as exemption at the exam board of the master programme at the HAN.

Standard 4 Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.

Conclusion

The full-time and the part-time study programme **meet** the generic quality on standard 4. Graduates achieve all learning outcomes during the programme and add good value to the international professional field and research field. They are valuable for the professional field because they possess a unique combination of knowledge on complex systems modelling and the ability to apply this knowledge in different practical contexts.
The end level is assessed in the minor projects (5 EC per module) as well in a final major project that leads to innovation in professional practice (30 EC). The major projects that the panel has studied show a variety of quality, ranging from excellent reports to reports on an average or minimal level. Grading by examiners matches these findings of the panel. Written feedback on the assessment forms can still be improved. In general, the panel sees relevant subjects, good mathematical modelling, meaningful use of IT-models and good reporting skills. The panel feels that the high level of this study programme could be shown even more by increasing the level of the major projects. The recent improvements in the assessment procedures offer good opportunities and expectations to realize this. Other suggestions of the panel are more attention to the relationship between theory and practice, and the consideration to differentiate the weighting of the learning outcomes in the assessment of the minor and major projects.

Findings and considerations

Graduation programme
The assessment on end level consists of a major project (30 EC) and a series of minor projects (5 EC per module). All projects lead to a solution, design or professional product. The major project leads to an innovative solution, design or product that can be implemented in professional practice directly. Examples of professional practices where students execute their major projects are chemical factories, automotive companies or logistic companies. For part-time students, the innovation in the major project applies the student's own work and profession. Students are guided by a HAN supervisor, who also functions as a second examiner. The company supervisor guides the student in the working environment. If a student graduates within a lectorate, the professor functions as the company supervisor. The major project committee assesses the major project presentation and defence. This committee consists of the HAN supervisor (second examiner), the company supervisor and an external expert. A second, independent examiner also assesses the written report and the presentation and defence. The final grades are established in a dialogue between the first examiner and the major project committee.

The major projects are assessed on all learning outcomes, that are divided over the 5 Dublin descriptors on the assessments forms. The student receives a grade for each Dublin descriptor (and matching learning outcomes). In the major projects that the panel has studied, students were allowed to compensate grades per Dublin descriptor. A criterium is seen as sufficient at 5,5 or higher. A student could pass with a partial grade between 4,5 and 5,4 for one or two of the Dublin descriptors, as long as the other grades could compensate these insufficient partial

grades. This model of assessment was chosen because all learning outcomes are already assessed in the minor projects. The panel does not support this system of compensating partial grades, especially because it was not always easy to track learning outcomes that were insufficiently judged at the major project, in the prior minor projects. This was due to the assessment criteria for the minor projects, that were not always directly linked to the learning outcomes. The panel has determined that examiners did indeed check adequately if each student achieved all learning outcomes during the programme, but the programme management told the panel that this was a lot of work.

The programme management has openly talked about this point to the panel and has offered the panel extra documents in which the current, more formal procedures of safeguarding the achieved learning outcomes are described. These new procedures are implemented in the summer of 2019 and the panel is positive about these necessary improvements of procedures. The first improvement is that the assessment criteria for the minor projects and the major project are levelled up (see standard 3). Another recent change is an extra go or no-go moment before students are allowed to present their major project in the final oral exam. This used to be a non-committing advice and is now a bounded advice where compensation is no longer allowed in the major projects. Examiners demand now that all learning outcomes are at least judged as 5,5 in the written part of the major project. The presentation of the major project can lead to higher grades but cannot compensate insufficient results of the written report.

Achieved learning outcomes
The panel has selected and examined the major projects and corresponding assessments forms of 15 graduates. The selection comprises a reasonable balance between satisfactory, good, and very good major projects. The panel examined 5 major projects of the part-time programme and 10 of the full-time programme. Different nationalities are represented in the selection. At the time of the site visit there were only graduates of the former two master programmes. The panel studied 9 final projects from the Master Automotive Systems and 6 major projects of the Master Control Systems Engineering. This selection was made accordingly to the number of graduates in each master programme over the last two years.

The panel concludes that graduates achieve all learning outcomes during the programme. In general, the panel sees relevant subjects, good mathematical modelling, meaningful use of IT-models in the major projects and good reporting skills in the English language. Graduates refer adequately to actual, scientific sources. The A point of improvement that the panel has seen in several major projects is the relationship between theory and practice. The panel sees some projects that are excellently executed by students, some projects that are of an average master level and some projects that are on a minimum master level. Grading form examiners fit these findings of the panel and are thus recognizable. Written feedback of examiners on the assessment forms varies from expanded to minimal. In some cases, the feedback could be expanded or better matched to the given grades.

Because of the high level of the curriculum, the panel feels that it would be desirable to extend this level to the graduation phase, by increasing the level of the major projects. The recent improvements in the assessment procedures offer good opportunities and expectations to realize this. Another consideration in improving processes is to start differentiating the weighting of the learning outcomes for the assessments of the minor and major projects. All Dublin descriptors

weigh the same now in the assessments, even though some Dublin descriptors cover more or more crucial learning outcomes in the opinion of the panel.

After graduating
Graduates feel well prepared for working in the international professional field or for starting a dissertation research. More or less half of the students stays in the Netherlands to work after graduation, whether or not at an international company. Other students cross borders to find a job, mostly within the European Union. Each year there are students that choose to start a dissertation research to obtain a doctorate. Some graduates stay at the HAN to teach and to obtain a doctorate. These graduates are a great addition to the team of staff members of the study programme, because of their international roots and recent experiences as being a student.

Representatives of the professional practice tell the panel that graduates of the study programme are a great value for the working field. Graduates possess a unique combination of knowledge on complex modelling and the ability to apply this knowledge in different practical contexts. The panel recognizes the remarks of the representatives from the professional field and feels that graduates from this unique master programme add good value to the international professional field and the research field.

General conclusion

Assessments of the standards

The panel comes to the following judgements regarding the standards:

Standard	Judgement full-time	Judgement part-time
Standard 1 Intended learning outcomes	Meets the standard	Meets the standard
Standard 2 Teaching-learning environment	Meets the standard	Meets the standard
Standard 3 Student assessment	Meets the standard	Meets the standard
Standard 4 Achieved learning outcomes	Meets the standard	Meets the standard

Considerations and conclusion

The full-time and part-time programme meet the generic quality on standard 1, 2, 3 and 4. The panel sees a professional master programme that offers theory on a high level. The curriculum is firmly constructed and up to date. The international character of this study programme adds value to the professional field and offers students from all over the world a chance to follow this unique master programme. The international inflow brings challenges, that are well managed by the professional team consisting of competent lecturers. In being a unique, applied sciences programme, it makes it necessary to keep on specifying the profile of the study programme towards the professional field. The structure of the curriculum and the assessment system are nicely in line with each other and give transparency in what is expected of students. In safeguarding the quality of the assessment there have been necessary improvements and further improvements can be made. This can be done by increasing the number of lecturers with a BEQ certification and by spending attention to the quality of exam questions and feedback. The panel encourages the exam board to take a stronger position while advising examiners and the programme management. The high level of this study programme can be shown even more by getting more out of the major projects, that show a variety of quality at the moment. The recent improvements in the assessment system for the minor and major projects offer good opportunities to realize this. Other suggestions of the panel are more attention to the relationship between theory and practice, and the consideration to differentiate the weighting of the learning outcomes in the assessment of the minor and major projects.

The findings and judgements are weighted and substantiated according to the guidelines of the NVAO. The panel assesses the quality of the full-time and the part-time Master Engineering Systems of the HAN University of Applied Science as **positive**.

Recommendations

The panel has the following recommendations:

Standard 1

- Intensify conversations with other universities in order to specify the profile of the study programme in relation to master programmes that focus on fundamental research.

Standard 2

- Investigate the possibility to give students more direct access to scientific literature of all publishers.

Standard 3

- Give more attention to the construction of questions in the written exams.
- The exam board can carry out their opinion and advices stronger.

Standard 4

- Give attention to the written feedback on the assessment forms for the major projects.
- Improve the translation from theory into practice for the major projects.
- Consider differentiating the weighting of the learning outcomes for the assessments of the minor and major projects.

Appendices

Appendix 1 Programme site visit

Dag 1: Donderdag 28 november 2019

Tijd	Onderdeel	Inhoud en werkvorm	Gesprekpartners	Opmerking
09.30 **09.50**	Welkomstwoord door managementteams Korte, informele kennismaking met vertegenwoordiging van beide opleidingen.		MT Ba MT MES Opleidingscommissie Ba Opleidingscommissie MES Voorzitter Curriculumcommissie Ba Voorzitter Curriculumcommissie MES	Ba en MES gezamenlijk.
09.50 **10.20**	Officiële aftrap van de visitatiedagen *(NVAO-standaard: 1 t/m 4)*	Introductiebijeen-komst panel en sleutelfiguren Ba en MES. Startend met korte pitch en demo werken in de driehoek.		
10.20 **12.30**	Materiaalbestudering opleidingsdocumentatie Ba en MES *(NVAO-standaard: 1 t/m 4)*	Het panel bestudeert de opleidingsdocu-menten die ter inzage zijn aangeboden. Twee studenten (Ba en MES) laten de digitale leeromgevingen zien (max. 10 minuten)		Ba en MES gezamenlijk.
12.30 **13.15**	Lunchpauze panel			
13.20 **14.45**	Rondleiding door de fysieke leeromgeving en werkruimtes *(NVAO-standaard: 2)*	Inkijkje in de opleidingen Ba en MES HAN. Uitnodiging aan het panel voor het stellen van vragen aan aanwezige studenten en docenten.		Ba en MES gezamenlijk Rondleiders: studenten/docenten Ba en MES.
14.45 **15.30**	Systeem van toetsing Ba en MES *(NVAO-standaard: 3)*	Inzicht in de wijze waarop de leerresultaten van studenten worden getoetst.	Gesprek met examencommissie en toetscommissie Ba.	Ba en MES gezamenlijk.

15.45 **16.15**	Gesprek met examencommissie Ba *(NVAO-standaard: 3 en 4)*	Inzicht in de wijze waarop de leerresultaten van studenten worden geborgd.		Ba en MES apart.
16.15 **16.45**	Gesprek met examencommissie MES *(NVAO-standaard: 3 en 4)*		Gesprek met examencommissie MES	
17.00 **17.45**	Gesprek met docenten van beide opleidingen *(NVAO-standaard: 1 t/m 4)*	Gesprek over het docentschap in het algemeen *(onderwijsontwikke-ling, professionalisering, samenspraak, taakverdeling binnen het onderwijs, toetsing en studentbegeleiding)*	Docenten/ Examinatoren Ba en MES	Ba en MES gezamenlijk
17.45	Afsluiting 1e visitatiedag		Managementteams en panel.	

Dag 2: Vrijdag 29 november 2019

Tijd	Onderdeel	Inhoud en werkvorm	Gesprekpartners	Opmerking
08.45 **09.00**	Korte terugblik dag 1 en vooruitblik dag 2.		MT Ba en MES	
09.00 **10.30**	Profiel van de beide opleidingen. De beoogde leerresultaten Ba en MES. *(NVAO-Standaard: 1)*	De visie van de opleiding op het werk en het werkveld van de Automotive Engineer, nu en in de nabije toekomst ▪ *Waar staat de opleiding nu?* ▪ *Waar komt ze vandaan?* ▪ *Welke keuzes voor de toekomst zijn gemaakt en met* wie? Aansluitend vraaggesprek met panel.	Directies Ba en/of MES Voorzitters van curriculumcommissies Externen Betrokken semester vertegenwoordigers.	

10.45 11.30	**Gerealiseerd eindniveau Ba. Het functioneren van alumni in de praktijk. Rol van onderzoek in startbekwaamheid.** ***(NVAO-Standaard: 4)***	**De mate waarin onze alumni voldoen aan de (internationale) eisen die het werkveld aan Ba-engineers stelt. Vraaggesprek over het functioneren van alumni in de praktijk.**	**Examinatoren: (Voorzitter Volante (alumnivereniging) ACE-programmaraad Alumni (geselecteerde afstudeerwerken.**	**Grote groep**
11.45 12.30	Gerealiseerd eindniveau MES. Het functioneren van alumni in de praktijk. Rol van onderzoek in startbekwaamheid. *(NVAO-Standaard: 4)*	De mate waarin onze alumni voldoen aan de (internationale) eisen die het werkveld aan MES-engineers stelt Vraaggesprek over het functioneren van alumni in de praktijk.	Major project board examinatoren. Werkveldbegeleiders Alumni Docent/alumnus Extern Begeleiders	Grote groep
12.30 13.15	Lunchpauze panel			
13.30 14.30	Gesprek met studenten Ba en MES.	Rondetafelgesprekken aan aparte Ba en MES- tafels met studenten. Panel kan aanschuiven naar gelang van de behoefte.		Ba en MES apart.
14.30 15.15	Onderwijsleeromge-ving	De omgeving waarin studenten, werkveld en docenten/onder-zoekers samen aan de beoogde leerresultaten werken.	Ba/MES	Ba en MES gezamenlijk.
15.20 16.30	Beoordelingsoverleg (Ba en MES).	Het panel beraadt zich over de bevindingen en het voorlopige oordeel.		Ba en MES gezamenlijk.
16.30 17.00	Terugkoppeling (Ba en MES).	Het panel geeft haar bevindingen en het voorlopige oordeel terug.		Ba en MES gezamenlijk.

Appendix 2 Documents examined

MES Master Engineering Systems Self-evaluation
Engineering Systems profile description
Bachelor Master output qualifications EQF
Document Totstandkoming eindkwalificaties
Strategieplan internationalisering FT 2018-09-11
Toetsbeleid Technische masters 2019
Visie Faculteit Techniek op Technische masteropleidingen
Lijst met docentgegevens
Connection Modules MES (intended learning outcomes-modules)
Selectie module matrices (EC, topics, assessment forms et cetera)
Degree statues (including Education and Examinations Regulations)
Brief NVAO akkoord planningsneutrale conversie (oktober 2017)
Instruction Manual Major Project
Onderlegger beoordelingsformulieren afstuderen
Lijst van afgestudeerden afgelopen twee jaar
Jaarverslag examencommissie 2018-2019
Selection of (online) study guides
Online learning platforms
Selectie schriftelijke tentamens
Selectie minor projects, inclusief beoordelingsformulieren
Selectie van literatuur
Minutes master advisory committee
Minutes programm committee

MAE Curricula
MAE Student contract
MAE Committees
MAE Application
MAE Äquivalenzprotokoll HAN TUC
MAE Contract