INDUSTRIAL ENGINEERING AND MANAGEMENT

FACULTY OF BEHAVIOURAL, MANAGEMENT AND SOCIAL SCIENCES

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This report was finalised on 13th of March 2017

REPORT ON THE BACHELOR'S PROGRAMME TECHNISCHE BEDRIJFSKUNDE AND THE MASTER'S PROGRAMME INDUSTRIAL ENGINEERING AND MANAGEMENT OF UNIVERSITY OF TWENTE

This report takes the NVAO's Assessment Framework for Limited Programme Assessments as a starting point (19 December 2014).

ADMINISTRATIVE DATA REGARDING THE PROGRAMMES

Bachelor's programme Technische bedrijfskunde

Name of the programme:	Technische bedrijfskunde
CROHO number:	56994
Level of the programme:	bachelor's
Orientation of the programme:	academic
Number of credits:	180 EC
Location(s):	Enschede
Mode(s) of study:	full time
Language of instruction:	Dutch
Expiration of accreditation:	31/12/2017

Master's programme Industrial Engineering And Management

Name of the programme:	Industrial Engineering And Management
CROHO number:	60029
Level of the programme:	master's
Orientation of the programme:	academic
Number of credits:	120 EC
Specialisations or tracks:	Production and Logistics Management (PLM); Health Care and Technology Management (HCTM); Financial Engineering and Management (FEM)
Location(s):	Enschede
Mode(s) of study:	full time
Language of instruction:	English
Expiration of accreditation:	31/12/2017

The visit of the assessment panel Industrial Management and Engineering to the Faculty of Behavioural, Management and Social Sciences of the University Of Twente took place on 12 and 13 October 2016.

ADMINISTRATIVE DATA REGARDING THE INSTITUTION

Name of the institution:	University Of Twente
Status of the institution:	publicly funded institution
Result institutional quality assurance assessment:	positive

COMPOSITION OF THE ASSESSMENT PANEL

The panel that assessed the bachelor's programme Technische bedrijfskunde and the master's programme Industrial Engineering and Management consisted of:

- Prof. dr. ir. R.E.C.M. (Rob) van der Heijden, Radboud University Nijmegen [chair];
- Prof. dr. H.M.C. (Harrie) Eijkelhof, Utrecht University;
- Prof. dr. E. (Erik) Demeulemeester, KU Leuven, Belgium;
- M.G. (Maarten) van Ruitenbeek BSc, University of Groningen [student member].

The panel was supported by dr. E. (Els) Schröder, who acted as secretary. Appendix 1 contains the curricula vitae of the panel members.

WORKING METHOD OF THE ASSESSMENT PANEL

Cluster

The bachelor's programme Industrial Engineering and Management Science and the master's programme Industrial Engineering and Management at the University of Twente were assessed as part of the cluster Industrial Engineering and Management and Systems Engineering, Policy Analysis & Management. The cluster Industrial Engineering and Management and Systems Engineering, Policy Analysis & Management encompasses eleven programmes at four universities: Delft University of Technology (hereafter: TU Delft), University of Groningen, University of Twente and Eindhoven University of Technology. TU Delft served as first point of contact and secretary on behalf of all four universities. Dr. Els Schröder, project manager at QANU, assisted the cluster in organisational and practical matters.

The project manager approached independent panel members based on the programmes' recommendations, taking into account specialised tracks at the four institutions. The NVAO approved the panel composition on the 10th of October 2016. The cluster panel consisted of the following members:

- Prof. dr. ir. Rob van der Heijden, Radboud University Nijmegen [chair];
- Prof. dr. Harrie Eijkelhof, Utrecht University;
- Prof. dr. Erik Demeulemeester, KU Leuven, Belgium;
- Prof. dr. Jan Kratzer, Technische Universität Berlin, Germany;
- Prof. dr. Arthur Petersen, University College London, United Kingdom;
- Prof. dr. Marcel Veenswijk, VU University Amsterdam;
- Dr Hens Runhaar, Wageningen University;
- Prof. dr. Emmo Meijer, Eindhoven University of Technology;
- Dr Margriet Nip, Tata Steel;
- Dr Hector Ramirez Estay, Université de Franche-Comté, France;
- Maarten van Ruitenbeek BSc, University of Groningen [student member];
- Sofie Vreriks BSc, University of Twente [student member];

Prof. dr. ir. Rob van der Heijden acted as panel chair during all four site visits. Additionally, prof. dr. Harrie Eijkelhof, an education expert with a long-standing academic career in the teaching of science, agreed to partake in all four assessments. Two QANU secretaries were appointed to assist the panel during site visits: QANU project manager dr. Els Schröder and dr. Barbara van Balen, independent NVAO-certified secretary. A calibration meeting took place on the 15th of December 2016 between prof. dr. ir. Van der Heijden, prof. dr. Eijkelhof and both secretaries to attune the panels' findings to further assure consistency of assessment within the cluster.

Site visit University of Twente

Preparation

In preparation for the assessment, the management provided a critical reflection for the bachelor's

and master's programme. In these critical reflections, the management described the current state of affairs and provided useful information for the assessment of its programmes. The project manager checked the report for completeness of information before sending it to the panel members. In consultation with the chair, the secretary selected thirty theses: fifteen bachelor theses and fifteen master theses, covering the full range of marks given. In addition, the selection covered a range of thesis subjects and represented the various examiners and master tracks.

Site visit
A site visit to the Faculty of Behavioural, Management and Social Sciences at the University of Twente took place on the 12th and 13th of October 2016 in the presence of all four panel members, assisted by an NVAO-certified secretary. Prior to the site visit, the panel asked the programme to select representative interview partners. It met during the site visit with the programme management, current students, staff, alumni, members of the examination board and members of the programme committee of both programmes. For the programme of the site visit, see Appendix 5.

The panel also examined relevant study material, assessment forms and additional material during the site visit. This material is listed in Appendix 6. The panel provided students and lecturers the opportunity to meet informally during a consultation hour outside the set interviews. No requests were received for this option. The panel used the final part of the visit for an internal meeting to discuss its findings. The visit was concluded with an oral presentation of the preliminary impressions and general observations by the chair of the panel. This presentation was open to all.

Report
Based on the panel's findings, a draft report was prepared by the secretary. All panel members commented upon the draft report and their comments were implemented accordingly. Subsequently, the programme checked for factual irregularities. Comments by the programme were discussed between secretary and chair and, where necessary, other panel members before finalising the report.

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

Generic quality
The quality that 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 standard.

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

SUMMARY JUDGEMENT

Bachelor's programme Technische bedrijfskunde

The bachelor's programme Technische bedrijfskunde (hereafter: TBK; 'Industrial Engineering and Management Science' in English) is a three-year programme, offered by the University of Twente. It aims to train good qualified professionals in the field of Industrial Engineering and System Engineering (hereafter: IE&SE), with good problem-solving abilities and a broad knowledge of the academic field. Graduates will be able to embark on further studies in the field and in adjacent programmes in engineering, or may choose to launch a professional career. Characteristic for the bachelor's programme is its unique and original didactic concept underpinning student-driven learning. Through multidisciplinary project work, students are encouraged to work with and alongside students from different disciplines. Consequently, the programme aims to educate highly independent and self-driven problem solvers, which are well prepared for a career in the intrinsically multidisciplinary work field that is IE&SE.

The bachelor learning objectives have been formulated in fifteen intended learning outcomes that are in line with (inter)national requirements. The learning outcomes reflect the bachelor's academic profile, paying attention to both professional academic and general academic qualifications. The panel approves the explicit division between professional academic and general academic learning outcomes, which it deems fit for a programme that trains students for a professional career in a highly competitive and challenging work field or further academic studies. Although the panel strongly advises the management to reflect on the nature of the current learning objectives, it established that the programme has adequate control over the interpretation of its learning outcomes at the appropriate degree level. The intended learning outcomes are adequately described and concretised in the curriculum design and as a result, they enable students to meet the required achievement level. In the panel's view, distinctive learning outcomes could further translate the unique features of the bachelor's programme at Twente, strengthening its current profile within the field.

The panel deems the bachelor curriculum design original, challenging and of the appropriate academic degree level. It provides a broad theoretical basis, is informed by relevant scientific research and incorporates professional demands and necessary skills to succeed in further studies or at entry level in the professional field of IE&SE. During their three years of study, students follow twelve modules, thematic overarching courses that are shaped by project work. In these modules, students are amply encouraged to deepen their knowledge of the disciplinary field as well as to explore adjacent disciplinary fields. The panel applauds the multidisciplinary set up of the curriculum, which allows students to reflect upon their own practice and development and which also simulates the tensions sometimes experienced in real-life working situations. It also appreciates the attention paid to personal development and to time management skills. It advises the programme to look into the design of their thesis preparation module to align the design and presentation of bachelor theses, while simultaneously reflecting upon ways in which to translate the remarkable multidisciplinary approach of the programme into the thesis design. It encourages the programme's management to keep the curriculum aligned with changes within the field, and to continue rejuvenating and developing the underlying teaching model.

The panel is positive about the support network for students, which encompasses a well-organised mentoring system; involved lecturers, senior students, management and support staff; an active programme committee and student association; and a good informal open-door policy that really works. The panel has verified in meetings with the programme management and academic staff that both have a proactive and problem-solving attitude towards problems within modules. The programmes are supported by academic staff with good research and teaching credentials. The panel is impressed by the intensity and flexibility of the staff and management, which both embraced the university-wide imposed educational redesign of the curriculum. It applauds the staff's willingness to experiment with its own teaching practice and is satisfied with the availability of didactic expertise to support staff at faculty level and to strengthen teaching practice at all levels within the university.

It recommends the programme to keep on allowing all teaching staff to continuously develop their teaching practice through reflection and further pedagogical training, and to stimulate its staff to expand their international networks through research and teaching in order to strengthen the programme's international profile and to further fortify its international ambitions.

The encountered student support network also allows for plenty of formal and informal feedback on teaching practice, curriculum design and assessment methods. The management, module coordinators and examination board formally assure the quality of assessment of the curriculum. Modules are regularly examined by the programme and its staff, and by institutional educationalists and the examination board. Spot checks, test screening and calibration procedures assure the quality of assessment at the programme. Nevertheless, the panel recommends paying further attention to the quality assurance of theses. It advises formalising existing practice or introducing new initiatives to further shape a structural mechanism for performing spot checks in order to assure the assessment quality of theses. It also advises the programmes to redesign its thesis assessment forms to allow for additional qualitative feedback and to introduce greater transparency into the assessment process by asking all examiners to fill in assessment forms independently.

The panel verified that bachelor students meet the intended learning outcomes at satisfactory level; it studied a representative selection of bachelor graduation projects and agreed with the assessment. The theses reflected sound disciplinary research at the appropriate degree level. The panel invites the programme to consider incorporating features of its unique multidisciplinary profile into the bachelor thesis' design in the future. Additionally, the panel spoke with recent graduates. It found recent bachelor graduates well-prepared for further studies, both within the field of IE&SE and within adjacent fields of study.

The bachelor's programme TBK at the University of Twente has many strong and some unique features, including a solid connection with the professional field, a science-based academic curriculum, an original programme design which allows students to take control over their own learning trajectory and to develop an independent and responsible attitude, and a strong multidisciplinary approach. The panel applauds the challenging and inspiring curriculum design and innovative approach of student learning, which it considers highly suitable for the field of IE&SE. Students perform at a satisfactory achievement level at a sufficient pace. The new curriculum design has increased the time weekly spent by students on their studies, which meets the panel's approval. Nevertheless, there is room for improvement at the programme, in particular with regards to the formulation of its learning outcomes and the formalisation of the quality assurance of their thesis assessment. Consequently, the panel assesses the bachelor's programme as a whole as satisfactory.

Master's programme Industrial Engineering and Management
The master's programme Industrial Engineering and Management (hereafter: IEM) is a two-year programme, offered by the University of Twente. Prospective master students are required to have either completed an international bachelor's degree, a completed degree of a Dutch University of Applied Sciences (hbo-level), or a degree of a Dutch Research University (wo-level). As an additional selection method, all prospective students are required to have completed Mathematics B at vwo-level and to show a sufficient mastering of the English language. IEM aims to educate academic professionals with an eye for long-term social, societal and environmental sustainability in the field of Industrial Engineering and System Engineering (hereafter: IE&SE), with excellent analytical and problem-solving abilities and a thorough knowledge of the academic field. Graduates will be able to embark on a professional career within their chosen specialisation tracks: Production and Logistics Management (hereafter: PLM), Health Care Technology and Management (hereafter: HCTM), and Financial Engineering and Management (hereafter: FEM).

The panel ascertained that the master's programme is concerned with suitable organisational problems in the field of IE&ES. It renders its profile appropriate. It appraises its focus on social and societal problems from an entrepreneurial viewpoint and approves of the three tracks,

focussing on management in production and logistics (track PLM), health care and technology (track HCTM) and financial engineering (track FEM). Of these, the panel established that HCTM and FEM are characteristic for Twente, distinguishing the master's programme in research interests within the domain of IE&IS. According to the panel, the focus of the programme – a multidisciplinary approach that links technology to management – is appropriate, yet not distinctive for Twente. It therefore encourages the programme to consider its focus for a more unique approach and profile within the field IE&IS.

The master's academic profile is translated into fifteen intended learning outcomes. These meet (inter)national requirements and are considered suitable, reflecting appropriate choices made by the programme specific for Twente. Nonetheless, the programme considers the intended learning outcomes wide-ranging. Consequently, they do not bring across Twente's take, approach, or profile in the panel's view. The panel ascertained that the generic learning objectives have been adequately interpreted into the master's curriculum design. The curriculum allows students to meet the intended learning outcomes: it allows for academic specialisation at the master's level, based on scientific research methods and up to date academic research. The panel renders the programme a good preparation for enrolment in a PhD programme or for a challenging career in industry and management. During their studies, students have ample opportunity to influence their study trajectory. All three tracks offer next to mandatory courses plenty of time for electives, both at the University of Twente and beyond its precinct. The panel appreciates this flexibility in the curriculum design, which allows students to acquire a strong individual profile. The panel encountered some connection problems with students enrolling in the programme at other moments than in September. It encourages the management to look into these problems and to address these in the forthcoming curriculum design.

The panel is positive about the support network for students, including involved lecturers, management and support staff, an active programme committee and student association. It encountered an informal open-door policy that really works for both students and staff. The panel has verified in meetings with the programme management and academic staff that both have a proactive and problem-solving attitude towards problems within courses. The programme is supported by academic staff members with good research and teaching credentials, who continuously reflect upon their teaching practice. It applauds the staff's willingness to experiment with its own teaching practice and is satisfied with the availability of didactic expertise to support staff at faculty level and to strengthen teaching practice at all levels within the university. It recommends the programme to allow all teaching staff to continuously develop their teaching practice through reflection and further pedagogical training, and to stimulate its staff to expand their international networks through research and teaching in order to strengthen the programme's international profile and to fortify its international ambitions.

The encountered student support network also allows for plenty of formal and informal feedback on teaching practice, curriculum design and assessment methods. The management, course coordinators and examination board assure the quality of assessment of the curriculum. Courses are regularly examined by the programme and its staff, and by institutional educationalists and the examination board. Spot checks, test screening and calibration procedures assure the quality of assessment at the programme. Nevertheless, the panel recommends paying further attention to the quality assurance of theses. It advises formalising the existing practice or introducing new initiatives to further shape a structural mechanism for performing spot checks in order to assure the assessment quality of theses. It also advises the programme to redesign its thesis assessment forms to allow for additional qualitative feedback and to introduce greater transparency into the assessment process by asking all examiners to fill in assessment forms independently.

The panel verified that master students meet the intended learning outcomes at satisfactory level; it studied a representative selection of master graduation projects and agreed with the assessment. The theses reflected sound disciplinary research at the appropriate degree level. Recent IEM graduates are highly successful at the job market and well-prepared for enrolling in PhD

programmes. In panel meetings, IEM alumni reflected a confident and professional attitude and expressed satisfaction with the way in which the programme prepared them for a career in academia and/or the professional field.

In the panel's view, a strong social and societal orientation, freedom of choice to direct personalised learning and good thorough academic training characterise the master's programme. The programme offers a solid curriculum in three tracks which the panel renders suitable for a master's programme in the field of IE&ES. Students perform adequately and within an acceptable time frame. The panel invites the programme to reformulate its learning outcomes and objectives in the upcoming programme redesign. It considers the IEM programme in Twente as a good preparation for a further career in science and in the professional field, yet encourages the programme to further diversify and/or specialise to create a truly unique profile and programme with distinguishing features. In addition, the panel advises to formalise the quality assurance of the thesis assessment. The panel assesses the IEM master's programme at the University of Twente on all four standards as satisfactory.

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

Bachelor's programme Technische bedrijfskunde

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

Master's programme Industrial Engineering And Management

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

The chair and the secretary of the panel hereby declare that all panel members 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 demands relating to independence.

Date: 13th of March, 2017

Prof. dr. ir. R.E.C.M. van der Heijden

dr. E. Schröder

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

Organisation of the degree programmes
The *bachelor's programme Technische bedrijfskunde* (hereafter: TBK; Industrial Engineering and Management Science in English) is a full time programme, consisting of 180 EC spread evenly over three years. It is taught in Dutch. The *master's programme Industrial Engineering and Management* (hereafter: IEM) is a full time programme, consisting of 120 EC spread evenly over two years. It is taught in English. Both programmes are based at the Faculty of Behavioural, Management and Social Sciences (hereafter: BMS) at the campus of the University of Twente in Enschede. Their lecturers are primarily based in two facultary departments: Industrial Engingeering & Business Information Systems (herafter: IEBIS) and Health Technology Services and Research (hereafter: HTSR).

TBK and IEM fall under the responsibility of a shared management, headed by the programme director. The programme director is assisted by the programme coordinator and closely advised by the students' advisor (in Dutch: studieadviseur). The *master's programme* is divided in three areas of specialisation, or 'tracks', which are directed by track coordinators in close collaboration with the management. A dedicated staff, student association, programme committee, examination board and involved alumni represent the various stakeholders and offer input and advise regarding the profile, curriculum and content of both programmes.

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. Insofar as is applicable, the intended learning outcomes are in accordance with relevant legislation and regulations.

Findings
In March 2016, representatives of the University of Twente, Delft University of Technology, Eindhoven University of Technology and University of Groningen agreed upon the contents of a domain-specific reference framework for the field of Industrial Engineering and System Engineering (hereafter: IE&SE), as included in Appendix 2. This domain-specific reference framework is formulated for both bachelor's and master's programmes in the field of IE&SE. At the University of Twente, the learning outcomes for both programmes are based on this domain-specific framework of reference. Unless otherwise stated, the panel's findings reflect on both programmes.

Domain-specific reference framework
The panel studied the domain-specific reference framework and finds it well-formulated. The framework was informed by international standards in the field as formulated by leading academic institutions, amongst which the Institute of Industrial Engineers, Stanford University and Georgia Tech. In the panel's view, the framework gives an adequate description of the profile and objectives of the international field in IE&SE.

The panel is satisfied with the listed competences for graduates and it renders the formulated learning outcomes appropriate for the field. It verified that the domain-specific learning outcomes meet the Dublin descriptors and compared these outcomes to the final qualifications as formulated in the so-called 'Meijers criteria'. It is satisfied that these learning outcomes meet international and national requirements. Regarding content and orientation, the learning outcomes encompass what might be expected of academic bachelor's and master's programmes in the field of IE&ES. Nevertheless, the

panel finds the differentiation between bachelor's and master's level in the learning outcomes too generic, in particular with regards to the listed general academic qualities.

Profile and aims
The *bachelor's programme's* profile and objectives are strongly shaped by a distinctive didactic idea, which was introduced for all undergraduate programmes at the University of Twente with cohort 2013: the 'Twents Onderwijs Model' (hereafter: TOM; 'Twente Education Model' in English). The panel studied the ways in which this educational model feeds into the profile and objectives of the bachelor TBK. It paid special attention to the translation of the TOM's unique and distinctive features into the bachelor's programme. The critical reflection, additional information provided on the TOM's didactic underpinning and meetings with the academic staff, students and management informed its views.

A distinctive feature of the TOM is that student-learning is strongly project-based and student-driven, demanding a self-reliant attitude from students. The management and staff enthusiastically embraced project-based learning at TBK; students work in project groups throughout their studies, regularly solving problems for companies and organisations. Another characteristic of the TOM is a strong multidisciplinary focus, feeding into mandatory shared modules for students from adjacent disciplines. TBK students work in modules and project groups with students from their own discipline and from other disciplinary fields, such as Business & IT, Applied Mathematics and Civil Engineering. While embracing the multidisciplinary approach, the programme also strongly emphasises its disciplinary focus. The panel finds that the TOM has resulted in a unique profile for TBK within the field of IE&ES, based on multidisciplinary approaches and project-based learning with added attention for social and societal relevance.

The panel also studied the profile, mission and objectives of the *master's programme* IEM. The programme aims to educate academic professionals with an eye for long-term social, societal and environmental sustainability. It offers hereto three tracks that are firmly rooted in the available expertise in Twente: Production and Logistics Management (PLM), Health Care Technology and Management (HCTM), and Financial Engineering and Management (FEM). These tracks reflect IEM's mission to offer a programme with a distinctive societal relevance in a dynamic and increasingly complex interconnected world. Within this changing environment, the programme singled out financial markets as a catalyst for change.

The panel establishes that the master's programme is concerned with organisational problems in contexts with a high societal relevance which it renders suitable for the field of IE&ES. It considers its profile appropriate. The focus of the programme – a multidisciplinary approach that links technology to management – is, according to the panel, not in particular distinctive for Twente. For a more unique approach and profile within the field IE&IS, the programme may want to reconsider its focus. The same is true for the track PLM, which could be found, under other names but with a similar orientation, at other Dutch institutions. Nonetheless, the panel recognises the unique orientation of both HCTM and FEM. These tracks are characteristic for the research interest at Twente and therefore distinguish the master IEM at Twente from other master's programmes in the Netherlands within the field of IE&IS.

Intended learning outcomes
In the critical reflection, both programmes present their intended learning outcomes as an apprehensive version of the domain-specific final qualifications. These intended learning outcomes are listed in Appendix 3. The panel studied the programmes' intended learning outcomes and compared these to those in the domain-specific reference framework. It concludes that the learning outcomes reflect most of the framework's requirements and that they are in line with the Dublin descriptors. The intended learning outcomes have been formulated in fifteen learning outcomes for both programmes, divided in professional academic and general academic qualifications. The panel approves the explicit division between professional academic and general academic learning outcomes, which it deems fit for both programmes.

At *bachelor's level*, the panel established that the intended learning outcomes are directed towards gaining an overview of the field, learning and applying quantitative, qualitative research methods and quantitative modelling techniques. The panel appreciates the emphasis in the learning outcomes on personal and professional development and on its focus on ethical and societal aspects of the profession, deriving from the programme's strong focus on social and societal relevance. At *master's level*, the panel concluded that the intended learning outcomes are directed towards the strengthening of the academic profile in a specialist area. The master programme's objectives focus on teaching its students to quickly identify, thoroughly comprehend, critically assess, correctly apply and creatively integrate scientific knowledge for analysing problems and designing solutions in complex cases. The panel ascertained that the intended learning outcomes prepare students to become independent and creative problem-solvers, with good academic skills and a thorough knowledge of scientific models, methods and literature at master's level.

The panel discussed the nature of the current general academic qualifications with the management to discover how these currently fuel student learning within the programme. Although they accentuate choices made by the programmes specific for Twente, they are still wide-ranging and therefore do not bring across Twente's unique take, approach, or profile. In addition, the panel considered the differentiation between bachelor's and master's level unclear. The management indicated that general academic skills and research methodology are tested throughout the programme. *Bachelor students* are asked to reflect upon academic articles, write papers summarising academic theory, present and discuss and interview a professional in the fields. They finish the programme with a portfolio, in which they reflect on their own personal and professional development and which are part of the module assessments. *Master students* peer-review another master thesis in their first year, write a review of a scientific article by a scholar in the department and discuss their review with the researcher in question, independently identify a suitable problem for their master thesis and formulate appropriate research questions.

The panel verified these statements in their meetings with students and alumni and by studying the available course descriptions. It is satisfied that the general academic learning outcomes are amply concretised in the curriculum of both the TBK and the IEM programme. It is confident that the programmes use the current learning outcomes in a fitting way to direct student learning to the appropriate academic degree level. Nevertheless, the panel strongly invites the management to concretise its intended learning outcomes for both the TBK and IEM programme. Currently, the curricula of both programmes function to define the nature of the learning outcomes. Clear, precise learning outcomes could manage student expectations, clarify objectives, inform curriculum improvement and make assessment more transparent. It would also further clarify the differentiation between both programmes, demonstrating even more clearly the added value of enrolling into a master's degree programme. Clearly defined, degree level specific learning outcomes could provide an additional control mechanism to direct student learning within the programmes.

During the site visit, the panel discussed the profiling and aims of the programmes with all stakeholders involved. Recurring themes were the multidisciplinary approach, autonomous attitude, self-directed study style, strong hands-on mentality, active involvement in societies and student boards and the strong sense of societal and social responsibility presented by TBK and IEM students. All these attitudes and characteristics translate in creative and proactive problem-solvers with solid scientific knowledge and good professional skills. The panel recognises the multidisciplinary approach as a strong feature of the current profile of both programmes, and also underlines Twente's reputation for education with a strong social relevance. If these distinguishing features were to be translated in recognisable learning outcomes, the programmes' unique profile could be further anchored within the field.

Considerations

The panel established that the domain-specific framework provides an adequate description of the characteristics of the field, resulting in an appropriate profile for graduates at both degree levels. It ascertained that the intended learning outcomes of both programmes are in line with (inter)national

requirements. The intended learning outcomes reflect the academic orientation of the programmes and enable students to meet the required level. The panel strongly encourages the programmes to further specify their learning outcomes. In the panel's view, distinctive learning outcomes would be able to translate the unique features of the bachelor's programme at Twente and further strengthen the master's profile within the field.

The panel strongly appreciates the unique profile of the *bachelor's programme* TBK. It deems its didactic model underpinning its programme original and fitting for the intrinsic multidisciplinary field of IE&ES. The panel defines the programme's strong multidisciplinary approach and project-based learning as distinctive features, creating a strong basis for further studies or a professional career. In the panel's view, the *master's programme* is concerned with relevant subject areas within the broader field of IE&ES. It appraises its focus on social and societal problems from an entrepreneurial viewpoint and approves of the three tracks, focussing on management in production and logistics (track PLM), health care and technology (track HCTM) and financial engineering (track FEM). Of these, the panel established that HCTM and FEM are characteristic for Twente, distinguishing the master's programme in research interests within the domain of IE&IS. According to the panel, the focus of the programme – a multidisciplinary approach that links technology to management – is appropriate, yet not distinctive for Twente. It therefore encourages the programme to consider its focus for a more unique approach and profile within the field IE&IS.

Conclusion
Bachelor's programme Technische bedrijfskunde: the panel assesses Standard 1 as 'satisfactory'.

Master's programme Industrial Engineering And Management: the panel assesses Standard 1 as 'satisfactory'.

Standard 2: Teaching-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.

Findings

Curriculum design and coherence: TBK
The panel studied the TOM and its implications for the design and curriculum of TBK. It read the provided critical reflection, and ascertained its findings during the site visit in meetings with students, staff and graduates of the programme. Additionally, it considered the aims of this specific education model and compared these to a representative selection of module materials and set assignments.

TOM was university-wide introduced with the start of the academic year 2013-2014. A TOM curriculum is organised in twelve ten-weeks full-time thematic course units or 'modules'. These modules are divided in five consecutive phases that allow for orientation (two modules), core knowledge acquirement (four modules), specialisation (two modules), diversification (two modules) and convergence (two modules). Throughout, reflection on and apprehension of scientific theory are incorporated into the various modules, just as the development of academic and professional skills. Many modules are multidisciplinary, bringing students from different undergraduate programmes together for instruction and project work.

In year one, TBK students start with two orientation modules: 'Introductie Technische bedrijfskunde' (module 1), followed with students from the bachelor's programme Business & IT, and 'Operations Management' (module 2), an introduction to basic organisational processes within companies. In the

second semester, they dive into the core programme of their discipline, while simultaneously collaborating with students from different disciplines in project work. They follow 'Business Intelligence and IT' (module 3), again with students from Business & IT, and 'Supply Chain Management' (module 4).

In year two, they start with the core module 'Finance for Engineers' (module 5), which focuses on the financial chain within businesses. In the module 'Consumentenproducten' (module 6), they experience a complete product design process for an actual client; students of TBK work together in project groups with students from Industrial Design and Mechanical Engineering. In this module, TBK students are required to move out of their disciplinary comfort zones; they follow courses in product design, production techniques and marketing, and they personally experience the tensions between the various stakeholders. In their fourth semester, TBK students are stimulated to specialise within their modules while simultaneously working with students from other disciplines. They take 'Van product design naar online business' (module 7) and 'Processen modelleren en optimaliseren' (module 8), the latter module with students from Applied Mathematics and Civil Engineering.

In their third year, students follow electives for 30 EC (modules 9 and 10). They may enrol in specific minor programmes, choose courses at other Dutch universities or study abroad. The sixth semester is dedicated to their individual graduation project. They prepare with a module dedicated to academic writing skills and academic critique, while reflecting upon their learning curve and academic and professional development throughout the programme in a portfolio. Additionally, they write a thesis proposal and secure a professional assignment for their graduation project (module 11). In their final module, students fulfil their assignments, communicating their findings within a relevant academic framework in their bachelor's thesis (module 12).

The panel applauds the choice for a student-driven education model that tailors towards the development of self-reliance and time management skills with the TBK students. According to the panel, the high-intensity modules in the first semester are challenging yet stimulating; they successfully prepare students for their active role in their own learning processes and acquaint them with the necessary skills for succeeding in project work. The panel is also very positive about the coherence of the programme and the structure of the various modules: it renders the curriculum innovative, original and challenging. All modules combine instruction, theoretical learning and the use of both academic and professional skills, allowing students to mature in their learning process. Students are stimulated to learn by doing in project work and to take control of their own learning process. The curriculum design enables students to meet the intended learning outcomes and allows them to develop into independent learners, with a high sense of responsibility and an academic and professional attitude.

The panel is in particular enthusiastic about the interdisciplinary projects in modules 6 and 8. These projects allow for the exploration of the added value of individual disciplines while experiencing the tensions between the various stakeholders' interests. Module 6, with its emphasis on learning outside the disciplinary comfort zone, creates a 'shock effect', to which students need to adequately respond. Students learn how to overcome the pressures posed by interdisciplinary demands. They also learn to neutralise the shock effect, while discovering and reflecting upon their own role in the process. In module 8, students explore their disciplinary value and grow into their role as professionals. In this way, TBK students become true team players. The panel members are convinced of the added value of interdisciplinary project work as experienced in modules 6 and 8 for TBK students, as TBK graduates tend to end up working in multi- and interdisciplinary environments. The TBK programme provides an excellent starting point for professional success in an intrinsically multidisciplinary work domain.

Nonetheless, the TOM model also poses challenges for the individual programmes at Twente. As TOM offers an interface programme, it calls for continuous efforts by all participating programmes to keep it up-to-date and relevant in a changing world and to translate it in programme-specific courses with a monodisciplinary identity and the depth required for a programme at bachelor's level. In addition,

its project-based learning orientation demands continuous scrutiny of the necessary skill sets and participating disciplines. The panel recommends the programme to closely supervise the developments within the field of IE&IS and to keep rejuvenating its bachelor programme in the coming years.

Certain core subjects demand a clear and structured approach to realise a successful learning curve for students. As a result, the integration of these subjects into the modules is considered challenging by the panel. Mathematics and research methodology are currently in danger of being treated as separate courses within the module structure, partly resulting from the fact that the Department of Mathematics is solely responsible for all teaching in the first subject. According to the panel, this disciplinary approach guarantees a successful learning curve for students and underpins a high level of teaching. Nevertheless, the panel encourages the management to integrate mathematics more into the modules. It suggests to tailor it towards topics considered highly useful for TBK students, for example towards modular processing and data analytics.

Research methodology is currently an integral part of the programme's modules, yet it is difficult to assess within a group project. The panel agrees with the programme that research skills need to be assessed on individual merit and that its methodology line deserves further attention. After conversations with the academic staff and management, the panel is convinced that informal checks are in place to guarantee a personal learning trajectory. The management already has plans in place to integrate research methodology into various project assignments in the impending academic year. The panel is satisfied with the suggested changes, yet recommends to additionally formalise feedback moments between module coordinators and the programme coordinator to further fine-tune the overarching learning curve in methodology training.

The panel has verified in meetings with the programme management and academic staff that both have a proactive and problem-solving attitude towards problems within modules. Staff and management regularly discuss the curriculum in formal and informal meetings, also with staff members of different disciplines. The panel acknowledges that tensions always may exist between tailoring towards a multidisciplinary approach in modules and disciplinary demands, and between individual study paths and group work. These tensions are inherent to the choice for an ambitious multidisciplinary approach, yet deserve the programme's ongoing scrutiny.

Curriculum design and coherence: IEM
For its view on the master's programme, the panel verified its findings in the critical reflection in meetings with all stakeholders involved. Additionally, the panel studied a representative selection of course materials and set assignments during the site visit. IEM is embedded in the faculty of BMS. Its academic staff is primarily based in two facultary departments: Industrial Engineering & Business Information Systems (herafter: IEBIS) and Health Technology Services and Research (hereafter: HTSR). IEBIS' research focuses on logistics, healthcare and the service sector. HTSR specialises in the impact of medical technologies on healthcare and on the improvement of personalised healthcare.

IEM's curriculum reflects its staff's research interests. The programme offers three tracks: Production and Logistics Management (hereafter: PLM), Health Care Technology and Management (hereafter: HCTM) and Financial Engineering and Management (hereafter: FEM). PLM addresses the design, planning and control, and optimisation of processes in manufacturing, logistics, supply chains and healthcare services. HCTM centers on entrepeneurschip in biomedical innovation in healthcare and on healthcare logistics. FEM focuses on identifying and quantifying financial risks in businesses and processes and on the management of these risks by using financial products and modifying business processes, mainly in the financial industry and within the traditional production section. In addition, IEM combines forces with other master programmes in engineering within the University of Twente. Students could follow certain 'study paths' as part of their electives, for example in manufacturing, maintenance, information management, finance, healthcare, construction and transportation in adjacent departments. Additionally, students actively partake in discussions with lecturers, guest

lecturers and fellow students and are encouraged to partake in orientation in the professional field through a skills portfolio. They work together in assignments in pairs, yet are individually tested.

In their first year, all students follow twelve courses of 5 EC each. They enrol in three mandatory courses: 'Introduction to Industrial Engineering and Management', 'Statistics and Probability' and 'Data Science'. Students of PLM and HCTM additionally follow 'Discrete Optimization of Business Process', and 'Simulation', whereas FEM students follow courses in 'Micro Economics' and 'Mathematical Finance'. In addition, students in PLM and FEM follow four mandatory courses in their respective tracks and three electives, whereas FEM students follow five mandatory courses and two electives. PLM students enrol in 'Supply Chain & Transport Management', 'Management of Technology for PLM', Advanced Production Planning' and 'Warehousing'. Students of HCTM follow 'Health & Health Systems', 'Optimization of Health Care Processes', 'Clinical Safety and Quality Assurance' and 'E-health Strategies'. Mandatory courses for FEM students are 'Introduction to Risk Theory', 'Structured Products', 'Risk Management', 'Management of Technology for FEM' and 'Management Control for Financial Institutions'.

In their second year, students choose electives in the first semester – provided that they are technically relevant and at the appropriate degree level. The management and staff stimulate students to study abroad. At the dawn of the semester, students are prepared for their graduation project in the course 'Preparation Thesis'. A skills portfolio is part of this preparation course. The skills portfolio consists of assignments that students need to fulfill throughout their studies. It includes academic skills such as writing an article review, selecting and reading relevant literature and drafting a research design. Certain assignments of this portfolio need to be exercised in the first quartile of their studies, yet are completed with this course; examples of these are a review of a MSc thesis and a first draft of a work field study. The final semester in the second year is dedicated to students' individual research project and to writing a master's thesis of 30 EC. Students are encouraged to set their graduation project in a real-life situation: they independently design a project, conduct research and write a thesis of academic relevance for a company or organisation.

The panel studied the intended learning outcomes and how these are met in the various courses over the tracks. It is positive about the design of the tracks and the coherence of course material within the tracks. It verified that the curriculum content and design enable students to meet the intended learning outcomes and that it also allows them to develop into independent learners, with a high sense of responsibility and an academic and professional attitude. The panel appreciates the amount of choice available to students, which allows them to become specialists with an individual profile tailored towards their interests and the demands of the job market.

The panel praises the attention paid to academic research methods and critique. It applauds the design of the portfolio and is particularly impressed by the work field study and the master's thesis review, both exercised by students in the first quartile of their first year. In the panel's view, these assignments assist students in appraising the expected level of research and research design. The panel is positive about the liberty of choice for students. Students therefore may design their own individual learning trajectory, enabled by a wide variety of suitable electives in adjacent disciplines and by clearly indicated 'study paths'. The panel was, however, surprised to discover that students of FEM have an additional mandatory course compared to HTCM and PLM students, yet accepts that FEM's objectives are slightly different from the other two tracks. The panel applauds the management's aim to address FEM's connection with the other two tracks in the impending curriculum redesign, planned for 2016-2017. An additional aim of the master's curriculum design is to further align the IEM master's programme with the TOM-bachelor's programme TBK.

The master programme has two starting moments: September and February. Students with a completed bachelor's degree of the University of Twente may, however, enrol every month into the programme. Students starting in September start with mandatory courses, whereas students starting in February enrol into electives. The panel feels that students starting in September have a more natural study path than those starting in February, and in particular those enrolling throughout the

year. It advises the management to study this connection problem with the redesign of the master's programme.

Academic and professional orientation
The *bachelor's* programme design and the way it is implemented into twelve modules assists students in meeting the final qualifications of the programme. The panel renders the used module material of the required academic level and up to date with current scientific research. During their bachelor studies, students develop research skills, learn to use and question scientific theory and models and aquire an academic, inquisitive and problem-solving attitude in project work. They are offered a good overview of relevant academic research in the field of IE&ES in the disciplinary core modules, while also being exposed to ideas and insights from adjacent disciplines. The panel is aware that multidisciplinary modules challenge the disciplinary focus of the academic programme. Nonetheless, it considers the disciplinary and multidisciplinary knowledge acquisition balanced. Students learn to reflect upon their own learning process and upon those of their fellow students, they present both individually and in groups, and manage collaborative project work. At the end, they successfully undertake an assignment in a professional environment and communicate their findings in a suitable academic manner in a bachelor thesis.

The panel finds the three tracks at IEM suitable for a *master's programme* in the field of IE&ES. It is positive about the academic orientation of the programme's design which enables students to become independent, well-trained academic professionals. It renders the used course material of the required degree level and up to date with current scientific research. During the programme, students develop further research skills, learn to use and question scientific theory and models, and they acquire an academic, inquisitive and problem-solving attitude.

The panel is positive about the academic orientation of both programmes. *Bachelor students* are first and foremost involved in analysis to gain knowledge of the scientific field, whereas *master students* reach a level of autonomy that allows them to formulate and carry out independent research projects based on design questions. It also appreciates the strong connection between the programmes and the work field, which allows students to thoroughly prepare themselves for their further prospective careers. For their portfolio, students interview alumni and visit alumni's companies to broaden their perspective on the job market. Students stated to actively benefit from alumni's business networks for finding work placements and for finding graduation projects at both bachelor's and master's level. Many alumni hosted internships for students from TBK and tutored students from IEM during their master graduation project. In the panel's view, all these measures result in a good academic professional orientation within both programmes.

Nevertheless, the panel noted that only a small proportion of students went abroad during their studies. Although international study is officially stimulated by the management, students at both *bachelor's and master's level* did not often grasp these opportunities. The panel advises the management to further strengthen its international ambitions by creating clearer options for an international semester in both programmes and by stimulating staff to establish international networks student exchange through their own research.

Study guidance
In its didactic approach, the *bachelor's programme* aims at a balanced combination of individual and group work in modules. Module coordinators, lecturers and tutors support students in their academic development, providing ample opportunities for asking questions, instruction and assistance while also supervising the (multi)disciplinary group projects. Additionally, so-called 'apprentices' support students throughout their studies at TBK. Apprentices are senior students, who serve as first point of reference and mentor. The panel discussed the role of these apprentices with the management, academic staff and students and concluded that apprentices are part of the fabric that holds the programme together, by ensuring that first-year students are an integral part of an active academic community from the start of their studies. Apprentices form an approachable and accessible help-

line for students struggling with the responsibilities inherent to a student-driven learning process. The panel finds the teaching format and study guidance appropriate for a bachelor's programme.

In discussion with the panel, the academic staff at TBK and IEM seems to have embraced the TOM. With its introduction, their teaching styles necessarily evolved from mostly instruction-based to tutoring at *bachelor's level*. They feel challenged to experiment with the slots reserved for instruction in the modules, trying out new methods such as pre-recorded video lectures for home study and plenary question sessions. They actively encourage informal feedback within their courses, and receive formal feedback from peers and fellow module teachers on the module design and from students in course evaluations.

The panel is pleased with the staff's enthusiasm and willingness to experiment. It is highly appreciative of the student-centred approach of their teaching at *bachelor's level*, which allows for personal touches and individual attention for students. It recommends the introduction of a more formalised structure for the organisation of feedback sessions between module teachers and module coordinators to discuss changes in module design and work forms in lectures and tutor sessions, yet highly appreciates the distinctive design of the bachelor's programme. The *master's programme* gives IEM students a chance to specialise within a specific field of IE&ES. During their studies, master students could seek advice with the students' adviser and members of the academic staff, when needed. Students in the programme mostly follow courses with students from the same track, yet encounter students from other tracks and disciplines in electives. They are closely monitored by their lecturers and course convenors.

The panel found students very positive about the availability and accessibility of the academic staff in both programmes. The academic staff mirrored the students' positive remarks and indicated to always find time to informally answer questions or provide additional instruction, when necessary. The facilities at TBK and IEM, an open and airy building offering many opportunities for gathering and discussion, positively advances group work and meetings between students and staff.

Students' work load
The panel studied both the students' work load and success rates for both programmes. During the site visit, in discussed with the academic staff, students, graduates and the management to verify the statements in the critical reflection.

The panel considers the *bachelor's programme* innovative and challenging, yet time-consuming for the academic staff and students alike. In conversations with the panel, the academic staff indicated to feel pressured for time by the introduction of the TOM and by the upcoming redesign of the master's programme. The staff agreed that bachelor students work harder under the new TOM curriculum than before the introduction of the new curriculum. Nevertheless, the staff also pointed out the added benefits for bachelor students: an increasing level of independence, capacity of self-management and a strong sense of responsibility and commitment. Bachelor students indicated to spend on average 32 to 38 hours a week on their studies. They highly appreciated the project-based learning, indicating the peer pressure in group work fuelled their studies. The panel was satisfied with these findings. In 2010, the visitation panel had been highly critical about the amount of hours spent by students of TBK on their studies. The TOM seems to have introduced a considerable improvement, while also introducing an element of responsibility and autonomy for students. The panel applauds this development and compliments the management with the progress.

Master students and recently graduated IEM students indicated to be satisfied with their work load. They spent at least 35 hours a week on their studies and did not identify specific problems within the curriculum design of the programme. Although the TOM redesign took place during their time of study, master students did not feel neglected by the programme management and academic staff; they felt both heard and seen. Current master students indicated to be well-informed about upcoming changes within the programme, and they are actively consulted about intended changes in the

redesign process. The panel concluded that the work load for master students is sufficient and in line with what may be expected from a master's programme.

In discussions with students and recent graduates of the *bachelor's programme*, the panel established that the introduction of the TOM came with its teething troubles. Certain courses were too heavily assessed, resulting in an excessive work load for students, in particular in module 1 and 11. The panel spoke regarding these teething troubles with students, staff, management and the programme committee, and it concluded that adequate measures were taken to assist the disadvantaged students of the first cohort. Additionally, necessary and appropriate changes were introduced to avoid these specific problems in the future. The programme committee and the study association Stress were both formally involved in these feedback and evaluation procedures. Informally, students also evaluated modules with the programme manager and programme coordinator. The panel concluded that the programme management and staff effectively reacted to both formal and informal feedback and sufficiently informed students about taken measures. Both academic staff and students are highly appreciative of the management's involvement, judging changes adequate. The panel is aware that no major education overhaul will be completed without teething troubles and applauds the cooperative collaboration between the programme management and its direct stakeholders.

Success rates
Many students finish their *bachelor studies* within three years after the official study start according to the critical reflection. The critical reflection also indicates improving success rates for the completion of *master degrees* within the scheduled two years. Students from the University of Twente are allowed to enrol every month in a master's programme. This slightly influenced the presented numbers, which confused the panel at first; nevertheless, the matter was clarified in discussions with the management, staff and students. Since September 2012, a 'Bachelor before Master' rule is in place to stimulate students to complete their third year in time to enrol in a master's programme by the following academic year. The panel concluded that this particular change had a positive effect on the master's success rates. The panel members praise the programmes for their improved success rates, especially at bachelor's level. In its view, the improvements are partly due to institutional change yet largely the result of a highly structured and original curriculum redesign that successfully prepares bachelors students for completion of the programme in time. The panel looks forward to seeing the implemented changes develop over time, as well as the effects of the new approach for the results at master's level. The panel ascertained during their site visit that the overall performance of both bachelor and master students have improved to satisfying levels.

Admission and selection
All students enrolling in the *bachelor's programme* have a Dutch secondary school diploma at vwo-level or equivalent, including Mathematics B at vwo-level. No specific vwo-profiles are required for enrolment. Prospective students with a hbo-propedeuse and no vwo-diploma, have to present proof of following Mathematics B at vwo-level. Furthermore, students are asked to partake in a matching process at the university to explore whether the programme meets their expectations.

Prospective *master students* are selected by the programme. They are required to have either completed an international bachelor's degree, a completed degree of a Dutch University of Applied Sciences (HBO), or a degree of a Dutch Research University. This widens the selection to students from a wide range of science and engineering backgrounds. As an additional selection method, these students from adjacent studies are required to have completed Mathematics B at vwo-level and to show a sufficient level in English. In discussion with the programme, further deficiencies are identified. Deficient students may enrol in a premaster programme which addresses mathematics, statistics and probability, and operations research. Two premaster programmes exist: one with courses for the equivalent of 30 EC and one with courses for the equivalent of 15 EC for Twente students' from adjacent programmes. These premaster programmes need to be completed within one academic year.

Although the panel recognises the programmes' autonomy in setting selection standards for enrolment, it was slightly surprised that only Mathematics B at vwo-level is a hard requirement for enrolment. It also indicated to miss an obvious TBK-profile in the selection criteria of the deficiency programme for enrolment in the master's programme. The management explained that Mathematics B has proven to be a very good selection method for determining whether students had the analytical mindset and academic skills required to succeed in the programmes.

The panel discussed the master's admission policy with current master students, both with a completed TBK bachelor or with alternative study backgrounds. Some of these students also followed the premaster; they felt well-prepared in the premaster and had no particular problems with following courses in the master programme. Nevertheless, they indicated needing to continuously work hard during their studies, identifying and addressing further small deficiencies. The TBK-graduates rendered their fellow students from adjacent studies capable and operating at an apt academic level. The panel concluded that the selection and admission policy of IEM is therefore appropriate.

Staff
The bachelor's and master's programme share a large proportion of their staff. The panel has studied the information in the critical reflection and appendices and concludes that the academic quality of the staff at both TBK and IEM is good. Nearly all staff members have obtained a postgraduate degree. At *bachelor's level*, 83% of the lecturers are active as researchers at research institutes of the University of Twente. At *master's level*, these numbers raise to 93%. Newly hired staff is obliged to acquire a 'University Teaching Qualification' (in Dutch: Basis Kwalificatie Onderwijs, hereafter: BKO), as required by university policy. Upon the introduction of this university policy, staff members with over twenty years of teaching experience were exempted from obtaining a BKO-qualification. All other staff members enrolled in the BKO-programme. Currently, 93% of all staff members is either exempted from further teaching training or qualified BKO-teachers at *bachelor's level*; these numbers raise to 96% at *master's level*. The teaching quality of staff is actively stimulated in Enschede. Active development of English language skills is highly encouraged: 87% of teaching staff is holder of the institutional English qualification or were exempted based on their acknowledged mastery of the language at both degree levels.

When questioned about the English language skills and didactic qualities of their lecturers and tutors, students were highly appreciative of the teaching staff. They also value the willingness of staff to guide them in one-to-one meetings and their openness to feedback. The panel is contented with the general level of skills and the qualifications of the academic staff at TBK and IEM. Nevertheless, it raised in conversation with the management and staff some concerns regarding the BKO-exempted staff's continuous development of their teaching practice, as refreshment courses are only compulsory for BKO-qualified teachers. The university offers through the Centre of Expertise in Learning & Teaching (hereafter: CELT) pedagogical and didactic advice, when invited or approached with specific questions. In collaboration with CELT, the management organises specific training programmes for staff under the name of 'Broodje Onderwijs'. Exempted staff is asked to actively reflect on their teaching practice in these voluntary training sessions. The panel is satisfied with the attention paid to exempted staff and stimulates the management to keep on supporting the professional development of all staff members.

The panel noted that, albeit the programmes' international ambitions as formulated in their internationalisation strategy in the critical reflection, staff tended to stay at Twente. It appreciated the internationalisation strategy that aims to improve international cooperation by student and lecturer exchange and that hopes to realise double and joint degrees in the future. Additionally, the panel advises the programmes' management to create more opportunities for its staff to go abroad on research leave to further establish and strengthen the programmes' international profile and ambitions, while further extending and intensifying the international network of potential partner universities for collaborative research or student exchange.

In the critical reflection, the management indicated their student-to-staff ratio as of current concern. The TOM has increased the workload for both academic and supporting staff. The pressure is further raised by the fact that certain education support systems are not yet appropriate for the registration of student results and are not compliant with the complex module structure of the TOM. Impending changes in the master's programme add to this workload. The management is currently hiring a professor and two lecturers to consolidate the teaching staff in Finance. The panel is under the impression that the concerns regarding the teaching staff are adequately met by the management.

Stakeholders
The panel looked into the active involvement of stakeholders in the programme design of both TBK and IEM. It derived information from the critical reflection and from meetings with the management, programme committee, teaching staff, students and alumni of both the bachelor's and master's programme. Both the programme committee and the student association Stress formally and informally advised the management on the curriculum redesign with the introduction of the TOM, and continue to do so. The academic staff was extensively involved in the programme redesign of TBK and is currently actively consulted in the redesign of the programme design of IEM. They continue to meet on a regular basis, both plenary and within module groups, to discuss the bachelor programme and the way it needs to feed into the master's programme, and to suggest changes into both programmes driven by scientific research and to counteract problems within both curricula.

The programme committee actively studies module evaluations and advises on measures to be taken in reaction to negative feedback by students. It also tracks the actions taken by the management regarding feedback. Stress organises informal evaluation and feedback sessions, now and then in the presence of academic teachers, and shares this information in informal discussion sessions with the management. Both students and academic staff indicated to benefit from an open-door policy, which results in informal conversations on the content of modules and the curriculum design. Students pointed out to be taken seriously when offering feedback on either the bachelor's or master's programme. They acknowledged prompt responses to negative feedback by both teachers and the management. They also were well-informed about adjustments in the programme design, both during module runs and after finishing modules.

Additionally, the programme greatly benefits from an active involvement of its alumni – both of the bachelor TBK and of the master IEM. Alumni are regularly asked back for guest lectures and network events at the department, which both receive a positive response from current students. In addition, alumni serve as an informal professional practice community and were invited to give feedback on the programmes' final qualifications, the various study paths within the bachelor programme and the design of the tracks in the master's programme. The management indicated in conversation with the panel to have discharged the work field committee, feeling that its members were not actively enough involved with the programme. Instead, it reached out to its alumni through LinkedIn and through the alumni association BeKader. Alumni feel involved and valued for their professional input.

The panel is positive about the active involvement of the various stakeholders in the curriculum design of both TBK and IEM. It ascertained that students, academic staff and the professional field are actively consulted about the programmes' design and that feedback and suggestions are adequately met. The panel verified that improvements are inspired by either changing scientific research or reasonable demands from students and the professional field. The panel condones current practices, but advises the programmes to formalise the professional participation of alumni in order to secure the lasting impact, for instance by installing an official alumni advisory board that is consulted every couple of years or by re-installing an independent work field committee.

Considerations
The panel established that the curriculum design of both programmes enables students to achieve the final qualifications. The panel concluded that the contents of both curricula are appropriate for the respective degree levels: they provide a thorough theoretical basis, are informed by relevant scientific research and have incorporated the professional demands and skills needed to succeed at

the job market. The panel renders the *bachelor's* curriculum design and content original and challenging. In addition, the panel is positive about the support network for students and the active involvement of the academic staff in supporting student learning. Students are well-prepared in the first half a year of their studies to take active control of their own learning trajectory and benefit from a well-organised mentoring system, in particular at bachelor's level. The panel verified that the 'open-door' policy at TBK and IEM really works: staff is available and accessible for students and very involved in their academic and professional development. It has some concerns regarding the informal nature of evaluation processes, feedback sessions and the involvement of the professional field and suggests the programme to look into structuring these processes for lasting involvement of all stakeholders.

In the panel's view, the *bachelor's programme* is exciting, innovative and inspiring; it offers students a good preparation for a professional career or further academic study. The panel is impressed by the successful collaboration between students from different disciplinary backgrounds in modules and by the added benefits for students' professional development. The interdisciplinary projects in certain modules allow students to explore the added value of their disciplinary approach, while simultaneously preparing them for a multidisciplinary work field. The panel praises the learning benefits of the created 'shock effect' between various disciplinary approaches in certain modules, resulting in a highly informative learning trajectory demanding flexibility, problem-solving abilities and reflection skills of the participating students. The programme is attractive for students who want a strong basis for further academic studies or a career in the professional field as long as the programme keeps aligning its curriculum with changes within the field. The programme has many strong and some unique features, including a solid connection with the professional field, a good science-based academic curriculum, an original programme design which allows students to take control over their own learning trajectory and to develop an independent and responsible attitude, and a unique interdisciplinary approach.

The *master's programme* IEM offers students a satisfactory preparation for their career. The panel is positive about the design of the tracks and the academic quality of the used scientific material, yet does not identify a distinguishing curriculum design or differentiating programme in comparison to other Dutch IEM programmes. It verified that the curriculum design enables students to develop into independent learners, with a high sense of responsibility, a strong individual profile as a result of ample opportunity to personalise their studies, and an academic and professional attitude at the appropriate degree level. Attention for social and societal relevance is appreciated, just as the attention paid to academic research methods and critique. The panel is enthusiastic about the design of the master's portfolio; it considers the portfolio a good preparation for the master's thesis and for a further career in the academic or professional field. It renders the master's programme a satisfactory continuation of the bachelor's programme, offering adequate disciplinary depth at the expected degree level.

Conclusion
Bachelor's programme Technische bedrijfskunde: the panel assesses Standard 2 as 'good'.

Master's programme Industrial Engineering And Management: the panel assesses Standard 2 as 'satisfactory'.

Standard 3: Assessment
The programme has an adequate assessment system in place.

Explanation:
The tests and assessments are valid, reliable and transparent to the students. The programme's examining board safeguards the quality of the interim and final tests administered.

Findings
The assessment system of the bachelor's and master's programme are identical in many respects. Unless otherwise stated, the panel's findings reflect on both programmes.

System of Assessment
The general assessment principles are outlined in the critical reflection. Since 2010, the University of Twente maintains an institutional framework for assessment policy (in Dutch: Toetskader), defining the necessary measures and provisions to promote and maintain the quality of tests and examinations. Both TBK and IEM meet the requirements in the institutional framework. In addition, the Faculty of Behavioural, Management and Social Science formulated its own assessment policy plan, working with so-called closed 'Plan-Do-Check-Act—cycles' (hereafter: PDCA-cycles). These PDCA-cycles allow for continuous and iterative improvement of assessment and of student learning.

A key instrument in the faculty's assessment policy is the programme's 'assessment strategy' (in Dutch: 'toetsplan'). Both TBK and IEM adopted the faculty's policy, offering a comprehensive programme assessment strategy. The programme strategy offers an overview, at bachelor's level per module and at master's level per course, of how and when specific learning outcomes are assessed by whom. Additionally, it clarifies the ways in which the final grade of each module or course is composed, ensuring transparency. The assessment strategies for both programmes are annually evaluated and discussed with the examination board. The faculty's education quality department annually evaluates each module and course through standard module and course questionnaires. When finding irregularities, it discusses these with the management. Furthermore, an independent process of test screening has been adopted in 2014 at TBK and at IEM. Each academic year, a TBK module and an IEM course, including all of its individual tests, are screened by independent educationalists from CELT. The results are discussed with the examiner(s), with the educationalist(s) and the programme management.

In digital appendices to the critical reflection, tables were provided with an overview of learning outcomes per module or course and the used assessment methods. The tables distinguish fifteen assessment methods, varying from written tests to oral examinations and from group assignments to individual assignments. These assessment methods are also widely communicated through the module and course objectives and assessment criteria. Examiners have developed means to increase the transparency of grading with model answers, test matrices and peer-review by colleagues to increase reliability of the assessment. The panel studied a representative selection of module and course assessments during the site visit. Prior to the site visit, it also studied the assessment strategy and additional material provided by both programmes. It appreciates the overall quality of assessment, concluding that the learning objectives of the courses are adequately tested and on the appropriate level of achievement. Students are well-informed about the assessment methods in the prospective and course manuals. Prior to their examinations, they are offered ample practice time with sample exam questions.

The programme director is responsible for the design of both programmes and for the process of testing and assessment. At *bachelor's level,* he is assisted by module coordinators that bear the responsibility for the design, planning, realisation, evaluation and improvement of the modules in close collaboration with the module examiners. At *master's level*, course coordinators are concerned with the design, planning, realisation, evaluation and improvement of the assessment and examination within courses. Module and course examiners are specifically trained in educational testing and the analysis of results. In conversation with the panel, both staff and students indicated to be actively involved with module and course evaluations. They are both contented with the way

in which the management and module and course coordinators acted upon suggestions for improvement.

The panel was surprised, however, by the fact that test results may be compensated within bachelor's modules. This allowance introduces the danger of students consistently evading to meet the intended learning outcome for a particular skill, because module coordinators are only responsible for the examination practice within their individual module and not for a designated learning trajectory over all modules. In conversation with the panel, both module coordinators and the management explained that students may only compensate one grade within a module, and that this grade must be at least 5/10. The programme coordinator, on behalf of the programme director, checks all compensated grades over all modules, ensuring that all learning outcomes are met by individual students within the complete profile. As a result, students cannot consistently compensate a particular skill or subject. The panel is satisfied that the programme has ample control over the process of compensation within modules. It encourages the management to clarify and formalise this procedure even further, for example by inviting the examination board or another designated committee or group to run another independent check.

Additionally, the panel discussed at length group assessment. In particular potential dodging and free-riding enjoyed the panel's scrutiny. At *bachelor's level*, students often work in small groups due to the TOM philosophy. The panel verified that the TBK programme uses several instruments to minimise individual students benefitting from group members' efforts. Group assignments and their assessments are part of independent test screening procedures. In addition, students are invited to peer-review their group members' contributions to flag evasion behaviour. In tutor meetings, students are interviewed regarding their individual involvement in project work. Oral examinations are part of most project work to identify an individual students' learning curve and his or her contribution to and participation in group work. The panel also learned that similar measures are taken to avoid free-riding at *master's level* in practical work, which is often executed in pairs. Master students have to individually pass an examination for their practical work in each course. When they fail their individual tests, they cannot obtain a pass grade for the course. In this way, the programme counters free-riding. The panel is satisfied with the measures taken by both programmes to minimise the risk on free-riding and avoidance behaviour.

Thesis assessment
The final assessment of the *bachelor's programme* is a 15 EC graduation project. Students complete an external research assignment at a company or organisation, solving a specific problem or answering a specific research question selected from a provided list or identified in collaboration with their internal and/or external supervisor. The graduation project's assessment is threefold: the process, e.g. the performance at the company, is graded and two deliverables: the bachelor thesis and a defence of the research outcomes. The final assessment of the *master's programme* is a thesis of 30 EC, based on a research assignment at an external organisation. Students independently identify a problem or research question, which they solve using qualitative and quantitative research methods and academic models and scientific theory. The graduation project involves a process assessment, the individual master's graduation report and a defence of the research outcomes. The student is academically supervised by two internal University of Twente examiners, who are appointed by the examination board, and by an external supervisor at the company or organisation. The panel agrees that these combined elements establish a student's achievement of the intended learning outcomes and demonstrate his or her professional academic skills at the appropriate level for both programmes.

A standardised assessment form is used for the evaluation of the graduation project at both levels. Per project, two internal examiners are appointed. These examiners commonly serve as first and second supervisor. Students are assessed on the following aspects: their research question; literary review and theoretical framework; research method/design; data collection/validation of the design; conclusion & recommendations/contributions to theory & practice; writing structure and style; independence and professional skills; and oral presentation and defence. At *bachelor's level*, the

conclusion & recommendations and their respective contribution to theory and to practice are marked separately. These respective contributions are graded collectively at *master's level*. The external supervisor may be consulted, but the two internal examiners determine together for all these aspects the appropriate full marks. Based on all aspects, a final mark is set. Further comments may be added in a small additional note box, and the assessment form is signed by both examiners. How separated aspects are weighted is not indicated on the form, yet staff confirmed that all aspects contribute evenly to the final mark.

The panel has assessed the quality of fifteen theses of both programmes and has studied the accompanying assessment forms. It concludes that the current assessment form is to some extent an underdeveloped tool in assessing the quality of the thesis. It provides some clarification and transparency into the assessment procedure and is consistent in outlining the aspects of assessment, but could be improved upon. As both examiners fill in the same form and determine grades together in conversation, students have no insight into the discussion between their examiners. The panel recommends filling in two separate forms for further transparency. A clear indication of the division of weighting between the various aspects may also benefit transparency and reliability. It also recommends appointing an independent second examiner for strengthening the objectivity of the assessment – a member of staff who is not involved at any point in the supervision of the student. Furthermore, the panel noted that the current assessment form only allows for assigning full marks to a particular aspect. It witnessed evidence of examiners trying to indicate a 7,5/10 instead of a 7/10 or 8/10. It advises to redesign the assessment forms to allow further differentiation, resulting in a higher flexibility and precision for examiners in their grading. The panel also feels that students might be helped by further individual feedback on the various aspects.

Examination board
The faculty of BMS knows four separate examination boards; uniformity between these four boards is secured in the 'chamber of chairs' at meetings between the four examination board chairs in attendance of a shared policy advisor. TBK and IEM sit in an examination board with the bachelor's and master's programmes International Business Administration. The examination board consistently checks whether students meet all intended learning outcomes before graduation. It also controls the quality of assessments. It does so by appointing examiners for each course and module. Courses and modules are regularly discussed by board members. The examination board runs test screens of modules and courses and discusses their results with the programmes' management. The panel ascertained in meetings that course and module quality and results from spot-checks are regularly discussed between the examination board and programme management and is satisfied with the level of commitment performed by the examination board.

Nevertheless, the panel concludes that the quality assurance of the assessment of theses is a cause for further action for the examination board. As of 2016, TBK and IEM entered theses into a 'thesis carousel' for quality assurance of the theses' assessment through an independent peer-review process. In the thesis carousel, external reviewers selected a representative selection of theses for further scrutiny. These peer reviewers then actively check the assessment and marking, evaluating the results with the involved examiners, the programme management and the examination board. The panel approves of this practice, which provides an independent control mechanism to check the level of assessment. The thesis carousel could potentially also function as a calibration tool.

Practically, the thesis carousel also functions as an independent check on the quality of the assessment of bachelor and master theses for the examination board. The panel invites the management and examination board to formally install the thesis carousel to assure the assessment quality of theses. Alternatively, the examination board may choose to install an independent assessment committee (in Dutch: 'toetscommissie') to perform these checks, leaving the thesis carousel the programmes' initiative for calibration purposes. Although the control of the examination board on the quality assurances of the thesis assessment must be strengthened, the panel is satisfied with current practices which informally performs the lawfully required check. As a result, the panel

concludes that the level of control of the examination board is sufficient to guarantee the quality of the assessment of the graduation projects in both programmes.

Considerations
The panel is positive about the assessment system of both the bachelor's and master's programme, and about the programmes' efforts to implement new assessment techniques. The quality of assessment and achieved learning outcomes is safeguarded at IEM and TBK, not only by an active examination board but also by a number of initiatives, including test screening and peer-review calibration by independent scholars in the thesis carousel. This practice also functioned as an independent quality assurance of thesis assessment for the examination board. Nevertheless, the panel concludes that to maximise the efficiency and effect of the quality assurance of the thesis assessment, further action is needed by the examination board to formalise this practice or to adopt an alternative suitable measure. In addition, the panel recommends the programmes to redesign their thesis assessment forms for qualitative feedback and additional transparency into the composition of grades. It also encourages assigning fully independent second examiners to further strengthen the assessment quality of graduation projects.

Conclusion
Bachelor's programme Technische bedrijfskunde: the panel assesses Standard 3 as 'satisfactory'.

Master's programme Industrial Engineering And Management: the panel assesses Standard 3 as 'satisfactory'.

Standard 4: Achieved learning outcomes
The programme 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.

Findings
Both bachelor and master students finish their studies with a graduation project, consisting of a thesis based on a professional assignment. All professional academic learning outcomes feed into the bachelor and master graduation projects and consequently, these projects are well-suited to determine the students' achievement level at the end of their studies. Prior to the site visit, the assessment panel studied fifteen theses of both programmes in order to establish the achieved level in the graduation projects. The panel confirms that all theses are of sufficient quality and it agrees with the assessment of all thirty theses. The level of achievement is on average satisfactory, often good and in individual cases outstanding.

At *bachelor's level*, students complete a research assignment, either at a research unit at the university or at a company, directed towards solving an existing problem or answering a research question with the use of relevant academic literature and some qualitative or quantitative modelling. At *master's level*, students independently identify a problem or research question, which they solve using qualitative and quantitative research methods and academic models and scientific theory. They are encouraged to base their research questions on an actual real-life problem at an existing company or organisation.

The panel confirms that the presented research in the *bachelor theses* was at an adequate level and embedded in relevant academic literature and theory. Nevertheless, the panel noted that many of these theses were messily presented: it found irritating spelling and language mistakes. It discussed this matter with both the academic staff and the management during the site visit. Both staff and management indicated to regularly advise students to tidy up their linguistic game. If students choose to ignore this advice, the sloppy presentation feeds into the overall mark. The panel was satisfied with these answers and actions, but wants to underline the importance of good written

communication skills for a further professional career. In addition, the panel was surprised by the wide variety in length and in the diversity of research designs. The panel encourages the management to consider setting a word limit and to pay further attention to the presentation of research in the preparation course, currently part of module 11. In the panel's view, the multidisciplinary nature of the bachelor's programme does not necessarily feed into the bachelor's graduation project, which is solidly disciplinary. It invites the management to ponder upon methods to bring the bachelor's unique multidisciplinary profile more into the graduation project.

Master theses demonstrated good mastery of scientific theory. The panel was satisfied with the quality of analyses in the studied theses and with the presentation of research. In its view, students pose relevant research questions, explain theory adequately and identify appropriate models, which they approach with an independent and critical academic attitude. It is satisfactory work at the right degree level, yet seems to stay clear from highly original work and innovative methods. Students clarify both positive and negative aspects of the used research methods and deliver well-formulated, appropriate and practical recommendations to companies and organisations in an orderly and clear manner. The studied theses suggest a well-structured preparation course that channelled student work according to a standardised and orderly plan resulting in a good quality graduation project. The panel advises the programme to keep paying attention to their students' presentation of research and their language skills and to guarantee the quality of theses of all respective tracks.

Virtually all *bachelor graduates* continue their studies with a master's programme. Many TBK graduates chose to continue their studies in the field and enrolled in a IEM master, both at the University of Twente and at other Dutch universities. The panel spoke during the site visit with recently graduated bachelor students, who are currently enrolled in the first year of the IEM master's programme. These students are from the first TOM bachelor cohort and are therefore representative for the current bachelor's programme. They confirmed to feel well-prepared by the bachelor's programme for their current studies and indicated to feel confident in their ability to complete their master studies. Members of staff emphasised the improved work attitude of TOM bachelor students and their ability to oversee multidisciplinary aspects within the field of IE&ES, compared to pre-TOM graduates. They also indicated that students' ability to plan their studies and to discipline themselves had vastly improved in comparison with pre-TOM graduates. Members of staff eagerly await the translation of this changed study attitude in the performance of TOM graduates in the master's programme. The panel found many indicators permitting a good performance of TOM students upon graduation, yet further evidence regarding the performance of future TOM graduates is needed for concise conclusions.

The level achieved by graduates of the *master's programme* is demonstrated by their performance upon graduation. The panel studied the tables provided for 2013 and 2015 in the dashboard, a digital appendix to the critical reflection. These tables have been prepared by the NAE/WO-monitor from the Vereniging Samenwerkende Nederlandse Universiteiten, and are based on two-yearly surveys amongst students of all Dutch universities. The panel learned that 95% of the graduates of cohort 2015 and 90% of cohort 2013 had launched their first job in the professional field within six months after graduation at various companies and organisations in the field of IE&ES. Students only incidentally enrol into PhD programmes. In conversation with the panel, both students and staff attribute this seemingly low enthusiasm for an academic career to the strong lure of the academically challenging professional field, in which graduates may continuously develop both their professional and academic skills. The management indicated to encourage aspiring and promising students to consider entering into a PhD, yet also stressed the appeal of a professional career.

The panel learned in the critical reflection and in conversation with the management that alumni serve as the management's sounding board regarding the connection between TBK and IEM and the demands of the professional field. According to the critical reflection, alumni are content with the achieved level of the programmes' graduates. This positive view was confirmed by alumni during the site visit. Alumni indicated to feel highly valued by the job market when entering themselves, but

also confirmed to actively encourage their employers to hire recently graduated students from IEM – and to a lesser extend from TBK.

A sufficient amount of alumni are actively involved with both programmes. They are invited to offer input regarding curriculum changes, give guest lectures and regularly take on the daily supervision during the bachelor and master graduation projects. The programmes' management and the study organisation Stress both actively stimulate contact between alumni and current students. With alumni of the bachelor's and master's programme International Business Administration, alumni of TBK and IEM actively take part in alumni events organised by their shared alumni group BeKADER. The panel praises these activities and the active ties between the programmes and their alumni. It appreciates the benefits of active connections with the professional field, which allow for orientation on the job market and which may even result in career opportunities for students.

Considerations
The panel ascertains that graduates of the *bachelor's programme* demonstrated to have achieved the intended learning outcomes at a satisfying level, based on the quality of their bachelor theses and on the indication of good performance during their master studies. All theses were adequately graded. These observations are also appropriate for the theses written by graduates of the *master's programme*, which also reflected a high proportion of achieved learning outcomes at the appropriate degree level. Furthermore, the panel concludes that master graduates are highly appreciated in the professional field and that students easily embark on promising professional and academic careers, in which their academic profile and skills are valued. The panel encourages the programme to pay more attention to the preparation course for the graduation project for bachelor students as well as to the written presentation skills. It also invites the management to consider translating the bachelor's multidisciplinary approach more into the design of the graduation project in order to further communicate the programme's unique profile.

Conclusion
Bachelor's programme Technische bedrijfskunde: the panel assesses Standard 4 as 'sastisfactory'.

Master's programme Industrial Engineering And Management: the panel assesses Standard 4 as 'satisfactory'.

GENERAL CONCLUSION

The panel ascertained that the intended learning outcomes of the bachelor's programme TBK and the master's programme IEM are in line with (inter)national requirements. It judged the learning outcomes rather generic and invites the management to further specify their learning outcomes at both levels. The panel is positive about the assessment system of both the bachelor's and master's programme, and about the programmes' efforts to implement new assessment techniques. An active examination board and suitable control mechanisms, such as test screening and calibration procedures, safeguard the quality of assessment at both programmes. Students meet the intended learning outcomes at satisfactory level, offering students a good preparation for a further career. The panel also congratulates the university on the ready availability of high-quality educational expertise and support for staff and management, yet advises the management to formalise certain feedback circles to further strengthen quality assurance within the department.

In the panel's view, the *bachelor's programme* has a unique, multidisciplinary profile which offers students a good preparation for a further career. The panel compliments the programme on its student-driven education model, at which student learning truly takes centre stage. This is reflected in an innovative curriculum at which multidisciplinary project work drives student learning. In the panel's view, the *master's programme* is concerned with relevant subjects areas with a clear social and societal orientation. The panel is positive about the design of the tracks and the academic quality of the programme yet it deems it neither distinguishing nor extremely innovative. It renders the master's programme a satisfactory continuation of the bachelor's programme, offering adequate disciplinary depth at the expected degree level.

Conclusion
The panel assesses the *bachelor's programme Technische bedrijfskunde* as 'satisfactory'.

The panel assesses the *master's programme Industrial Engineering And Management* as 'satisfactory'.

APPENDICES

APPENDIX 1: CURRICULA VITAE OF THE MEMBERS OF THE ASSESSMENT PANEL

Panel chair

Professor Rob Van der Heijden graduated in 1981 from Eindhoven University of Technology as a building engineer. He received his PhD in Building Engineering from the same university in 1986. From 1987-1993 he worked as (Associate) Professor at the Faculty of Building Engineering of TU Delft. In 1994, he was appointed Full Professor in Transport and Logistics at TU Delft. Radboud University Nijmegen offered him a position as Full Professor in Urban and Regional Planning in 2001. Between 2008-2010, he was Director of Research at the Institute of Management and Vice-Dean of Research at the Nijmegen School of Management (NSM). Professor Van der Heijden was Dean of the Nijmegen School of Management from 2011-2016. Since June 2016, he is Professor in Innovate Planning Methods within the NSM. His research is in the fields of spatial planning, decision making and governance with a special focus on issues of transport, logistics and infrastructure development.

Panel members

Erik Demeulemeester is Full Professor at the Faculty of Economics and Business (since 2001) and Head of the Research Center for Operations Management at KU Leuven in Belgium. Additionally, he is Chair of the Department of Decision Sciences and Management Informatics. Erik Demeulemeester received a degree as commercial engineer in Management Informatics in 1987, a Master of Business Administration in 1988 and a PhD in 1992, all from KU Leuven. Professor Demeulemeester is a member of the editorial board of the *European Journal of Operational Research*, the *Journal of Scheduling, Computers and Operations Research* and the *European Journal of Industrial Engineering*. He is a jury member for the EURO Excellence in Practice Award (EEPA), which will be awarded at the EURO-k conferences in 2016, 2018 and 2019. His main research interests are project scheduling and health care planning, both feeding into his current teaching practice and his numerous publications.

Professor Harrie Eijkelhof has specialised knowledge of didactics and teaching methods in science education. Until his retirement in 2014, he was Director of the Freudenthal Institute for Science and Mathematics Education at the Faculty of Science at Utrecht University (2011-2014). Previously, he was Professor of Physics Education at the Faculty of Physics and Astronomy at the same institution (1997-2011). Professor Eijkelhof has ample experience in teaching, educational models, didactics, assessment and professional development of executives in university education. From 2005 to 2010, he was Vice-Dean of undergraduate studies at the Faculty of Science, Chairman of the Board of Studies of the Undergraduate School, member of the examination board of Liberal Arts and Sciences and a member of the Advisory Board of Education at Utrecht University.

Maarten van Ruitenbeek BSc (student member) is a second-year master's student in Industrial Engineering and Management at the University of Groningen. Besides his studies, he follows the High Tech Systems and Materials Honours Programme in collaboration with Royal Philips Drachten and tutors first-year bachelor students in Industrial Engineering and Management. Van Ruitenbeek completed his bachelor Industrial Engineering and Management Science at the University of Groningen in 2015. In 2015-2016, he was chairman of TBV Lugus, the student association of Industrial Engineering and Management in Groningen.

APPENDIX 2: DOMAIN-SPECIFIC FRAMEWORK OF REFERENCE

Domain-Specific Frame of Reference Industrial Engineering and Systems Engineering
(As confirmed in Utrecht on 10 March 2016)

This document has been written as a short summary of views on the field of Industrial Engineering and Systems Engineering (IE&SE). These views have been gathered from organizations that focus on the professional development and application of the field http://esd.mit.edu/;http://www.abet.org/). In addition, SE engineers (http://www.iienet.org; http://msom.society.informs.org; http://www.informs.org; http://www.incose.org) and leading academic programs in the field (http://ieor.berkeley.edu/; http://www.isye.gatech.edu/; http://www.cesun.org; http://www.stanford.edu/dept/MSandE/; http://www.epp.cmu.edu/; http://esd.mit.edu/; http://www.seor.gmu.edu/). A few excerpts from these texts are included in the separate text box.

Although there are some clearly common elements in these descriptions, we observe that the various different emphases of these organizations' IE&SE programs have necessitated each of them to formulate their own view of what the field of Industrial Engineering and Systems Engineering represents in education, application, and research. The same also holds for the IE&SE programs at UG, TUD, TUe, and UT. This document gathers the overarching elements of these programs, but we emphasize that each of these IE&SE programs has unique elements that will be highlighted in the self-assessments.

1. Common elements of the field of IE&SE
These common elements concern: (a) the common basis, (b) the focus: (re-)design, implementation, installation, and improvement of products, processes and systems, (c) broadly applied in private and public domains and within and between organisations, (d) the application of quantitative methods (and combination with qualitative methods), and (e) complex problem solving with a scientific and a pragmatic multidisciplinary approach.

(a) The common basis
Industrial Engineering (IE) and Systems Engineering (SE) are interrelated.[1] IE is concerned with the design, improvement, implementation and installation of integrated systems of people, information, materials, equipment and energy. It focuses on the analysis, design and control of (innovative) processes, products and systems in an industrial and/or societal environment, both at the level of individual organisations and supply networks as well as strategic issues. It involves the use of new processes, materials and production- and manufacturing techniques in innovative ways. SE mainly focuses on inter-organisational questions that involve the use of technology and the interests of multiple stakeholders, typically linking public and private organisations. As a consequence the common basis of IE en SE draws upon specialised knowledge and skills in the mathematical, physical, chemical and social sciences together with the principles and methods of engineering analysis and design in order to specify, predict, and evaluate the results to be obtained from the systems involved.

(b) The focus: analysis, design, implementation, and performance improvement of processes, critical infrastructures, and systems
IE&SE is concerned with the design and improvement of operational and/or strategic processes and integrated systems. These processes or systems provide products or services to customers or to the society at large. As such both private and public organisations are concerned. The design and improvement of products, processes and systems considers multiple goals and the availability of limited resources, such as time, money, materials, energy and other resources. Several organizations and multiple stakeholders may be involved (supply chains, alliances, public-private partnerships) and governance structures can be part of design and improvement initiatives. The scope of design thus may include supply chain networks, production and manufacturing techniques, products, control of

[1] "Industrial Engineering" refers to the programmes at TU/e and UT, while the term "Systems Engineering" better fits most programmes at TUD.

systems, implementation, installation and validation. The multidisciplinary, integrated design approach including the design context distinguishes IE and SE's from specialized engineering disciplines. In summary, IE's and SE's may be considered Productivity and Efficiency Professionals.

(c) Broadly applied, both in private and public domains and both within and between organizations

IE&SE is used in a variety of fields. It applies along all steps in the product life cycle, from research and development over design, manufacturing, distribution and disposal. And it applies in all phases of the value chain. Whereas initial applications were mainly limited to industrial settings, we now witness more and more applications in the service industry. Its principles apply as well in all fields of the private as in the public sector. Today there is a fast growth of applications in banking, healthcare, transportation, and the like.

Therefore the term "industrial" can be misleading; this does not mean just manufacturing. It encompasses service industries as well. It has long been known that industrial engineers have the technical training to make improvements in a manufacturing setting. However, many of the same techniques can be used to evaluate and improve productivity and quality in a wide variety of service industries, as well as in the public sector. The term "Systems Engineering" emphasizes this broader scope for design, improvement, and problem solving.

(d) The application of quantitative and qualitative methods

IE&SE is a field of engineering and one important element of its approach to the design and improvement of products, processes and systems is the use of data analytics and quantitative modelling methods. These are derived from fields such as operations research, management science, mathematics, natural sciences, economics, data analysis and statistics, information systems, game theory (gaming, simulation and Q-methods), engineering and social science methods such as interviews and questionnaires.

(e) Complex problem solving with a scientific and pragmatic multidisciplinary approach

Complex problems where value systems may clash and the status of knowledge claims may be disputed are central to IE&SE. In order to be able to solve these kinds of problems, it is necessary to synthesize knowledge from different disciplines (e.g., engineering, natural sciences, (institutional) economics, mathematics, organizational behaviour, law, psychology, although not all disciplines are equally important in all problem domains). IE&SE draws upon specialized knowledge and (analytical) skills in the mathematical, physical, and social sciences, together with the principles and methods of engineering analysis and design. Unlike traditional disciplines in engineering, IE&SE addresses the role of human decision-makers and other stakeholders as key contributors to the inherent complexity of systems. The programmes offer the relevant knowledge and skills from different disciplines and provide a framework for the application and integration of this knowledge in analysing a problem situation and in designing and implementing solutions. In brief, IE's and SE's might support (scientific) decision making.

Besides scientific IE&SE people also ought to be pragmatic people. They work to understand and resolve real problems from society and hence - as stated above - need to combine the knowledge and experience from many disciplines to develop project and process-management expertise and communication skills. They choose their method so as to fit the problem, which means that they combine the quantitative and problem-solving approach of engineers with research methods and qualitative insights from the social sciences.

2. Generic competences

Taking into account the before mentioned common elements of the field generic competencies for industrial and systems engineering are listed below:

- Sufficient understanding of science, technology and technological innovation;
- Keen analytic mind-set combined with a drive to synthesize towards a solution;

- Competent in translating complex issues in workable models and design and execute appropriate research programmes;
- Adequate mathematics skills for modelling and executing research activities;
- Able to conduct standard experiments, tests and measurements, and to analyse and interpret and apply the results in order to improve products, processes and systems;
- Able to (re)design products, processes and systems in an IE&SE context;
- Adequate understanding and competences in a number of technical, economic and social disciplines to underpin research programmes;
- An adequate understanding of the drivers of socio-,economic and political organizations in society;
- Able to assess the impact of IE&SE products, processes and systems in a business, societal and global context;
- Able to organize and drive for efficiency and effectiveness;
- Resourcefulness and creative problem solving;
- Excellent communication, listening, and negotiation skills;
- Ability to adapt to many environments, interact with a diverse group of individuals and understand the roles of various stakeholders in the processes;
- Experience in working in an interdisciplinary and international environment;
- Able to identify the arising ethical dilemma and to reflect on this dilemmas.

3. BSc and MSc levels

The specific blend of competencies varies per programme and is laid down more specifically in the final qualifications of each programme. Although the emphasis varies among the programmes, there is a differentiation between the BSc and MSc levels regarding to

- Complexity of the problem situations (in terms of technical and/or stakeholder complexity and/or the number of disciplines involved);
- The amount of information necessary, known, and available from the practical problem situation;
- The level of autonomy.

Bachelors receive a sound general education in basic fields of IE&SE, like Natural Sciences, technology, engineering, optimisation, production- and process techniques, engineering economy, business economy, organisational theory, social sciences, etc...) However, specific choices in these basic fields, varies per programme. They should be able to continue studies on a more in depth and specialised Master's track or they may fill appropriate positions in business.

Master programs in IE&SE generally offer different fields of study in which students can specialise. Examples of such fields are operations management, operations research and management science, CIT, product design and logistics, policy analysis, man-machine systems, performance analysis, supply chain management, process- or production techniques, innovation processes, control engineering, etc.

Whereas bachelors are mainly involved in analysis (as the initial step in the design cycle), Masters typically deal with design questions. Above that they should also be exposed to research questions. Masters should be able to formulate and carry out independent research projects.

The IE&SE Bachelor programs provide an excellent basis for one of the IE & SE Master programs, but students in IE&SE Master programs also can have various undergraduate backgrounds in engineering and other quantitative fields. Graduates of a Master's programme will typically start their career as engineers, project or planning managers, functional managers, policy analysts/advisers, engineering consultants and the like. But they may as well start an academic track through further involvement in research (e.g. PhD and academic positions). They should be able to move later on to managerial positions (e.g. as CTO). Some may prefer to become private entrepreneurs.

Excerpts from: http://www.iienet.org/Details.aspx?id=282

Institute of Industrial Engineers (IIE) **Definition of Industrial Engineering:**

'IE is concerned with the design, improvement and installation of integrated systems of people, materials, information, equipment and energy. It draws upon specialised knowledge and skill in mathematical, physical and social sciences together with the principles and methods of engineering analysis and design, to specify, predict and evaluate the results to be obtained from such systems'

Excerpts from http://www.stanford.edu/dept/MSandE/about/MSandE-5yr.pdf

Stanford Engineering established the Department of Management Science and Engineering five years ago with a logic and a purpose: engineers know how to analyze and solve problems and they thoroughly understand technology. With this quantitative background and additional training, for example in social sciences or finance, engineers should therefore be leaders in management and public policy.

The department's eight research areas [are]: organizations, technology management and entrepreneurship; production and operations management; decision analysis and risk analysis; economics and finance; optimization and the analytical tools of systems analysis; probability and stochastic systems; information science and technology; and strategy and policy. MS&E also includes several centres and programs such as the Energy Modelling Forum and the Centre for Work, Technology and Organization. In addition, it hosts the Stanford Technology Ventures Program. The department's strengths are also manifest in the talents of students and alums who work in investment banking, management consulting, and other fields that have not been closely associated with engineering in the past. These fields will be in the future because a deep understanding of technology has become critical to their operations. "For example, a growing number of people address finance problems using methods that have been traditionally associated with engineering systems analysis," says Paté-Cornell, referring to the fast-growing specialty of financial engineering. Paté-Cornell's hope is that more engineers will also join the ranks of government and use their skills to shape and implement policies.

MS&E students gain the training that they need to be leaders in finance, industry, policy, or other specialties by completing a core engineering curriculum, followed by a concentration in an area such as finance, operations research, production, or public policy.

Excerpts from www.isye.gatech.edu

Georgia Tech: Industrial engineering (IE), operations research (OR), and systems engineering (SE) are fields of study intended for individuals who are interested in analyzing and formulating abstract models of complex systems with the intention of improving system performance. Unlike traditional disciplines in engineering and the mathematical sciences, the fields address the role of the human decision-maker as key contributor to the inherent complexity of systems and primary benefactor of the analyses. In short, as practitioners and researchers in IE/OR/SE, we consider ourselves to be technical problem solvers. We are typically motivated by problems arising in virtually any setting where outcomes are influenced by often complicated and uncertain interactions, involving a variety of attributes that affect system performance. Against this backdrop, students have historically been attracted to our academic programmes with a variety of career objectives and from a host of disciplines and academic interests.

APPENDIX 3: INTENDED LEARNING OUTCOMES

Bachelor's programme Technische Bedrijfskunde

		TBK Final Qualifications
		A. Professional academic qualifications
A: Professional Academic		***Generally:***
		The graduates of the BSc programme are able to analyze problems and define required improvements for the design and control of operational processes (the IEM domain) at an academic level. Moreover, they are able to implement such improvements. The difference between BSc and MSc is, that BSc graduates are able to perform these activities in relatively simple cases. This involves defining problems and research questions; describing intended results, scope of research and design efforts, available resources; determining the constraints for feasible solutions, from different perspectives (such as: organizational, legal, financial, ethical, professional norms) and for different stakeholders (such as: employees, shareholders, suppliers, local community, regulators); defining criteria for evaluating alternative solutions.
		BSc final qualifications
		So, the undergraduate is able to identify, comprehend, assess, correctly apply, and integrate existing scientific knowledge that can be used for analyzing problems and designing solutions, in the domains of: > production and logistics; > information systems; > finance and accounting; > other fields in business administration (law; marketing; human resources); > mathematics, statistics, empirical research methods.
	A1	Has a global overview of the structure of research and design processes and is able to > identify the various steps in performed research and design > properly break up own research and design activities into subprocesses *These processes are intertwined: Research is needed for producing knowledge that is used for designing solutions in a specific context. Such knowledge is produced in a purposeful and methodical way (using scientific research methods). It may or may not be generalizable knowledge*
	A2	Has an overview of quantitative and qualitative empirical research methods and is able to > analyze performed research as to the methodological aspects > select an appropriate method and explain this choice for research to be performed > apply this method in relatively simple cases
	A3	Has an overview of quantitative modeling techniques for operational processes, specifically in the domains of > Operations research models > Information systems models > Finance and accounting models and is able to > analyze the results of modeling activities > select an appropriate modeling technique and explain this choice > apply this technique in relatively simple cases.
	A4	Is able to integrate existing knowledge, modeling techniques, and research results for designing, validating, and selecting solutions in relatively simple cases This is challenging, because existing knowledge may not fully apply to a specific situation, models are always stylized, empirical research always has limitations, and some aspects have been left out of scope from the beginning anyway
	A5	Has an overview of implementation methods and processes and is able to > (critically) analyze ongoing or finished implementation processes > plan globally an implementation process in a relatively simple case
	A6	Has an overview of evaluation methods and techniques and is able to > analyze the results of performed evaluations > select appropriate evaluation methods and explain this choice > carry out an evaluation in relatively simple cases
	A7	In order to be able to meet these competencies, the graduate must have mastered the following disciplines: > mathematics and statistics - [2] (see Legend) > finance and accounting - [2] (see Legend) > production and logistics - [2] (see Legend) > information systems - [2] (see Legend) > law, organization theory, marketing - [1] (see Legend)
		B. General academic qualifications
B: General academic		***BSc final qualifications***
	B1	Is able to work autonomously and self-reliant
	B2	Is able to work in teams.
	B3	Is able to communicate properly (in oral and written form) with various stakeholders
	B4	Is able to conduct a bibliographic search and knows how to reference correctly
	B5	Is able to reflect on professional behaviour and ethical and societal aspects of work
	B6	Is able to reflect on and direct personal and professional development
	B7	Is able to manage and concretize effectively his own learning process in the context of a MSc programme.
	B8	Has enough basic knowledge and competencies to follow a broad range of MSc programmes which are adjacent to the IEM domain.

Level	Legend
[1]	Knowledge of the basic concepts and principles
[2]	Application in relatively simple and monodisciplinary cases
[3]	Application in relatively simple interdisciplinary cases

		IEM Final Qualifications
		A. Professional academic qualifications
A: Professional Academic		**Generally:**
		The graduates of the MSc programme are able to analyze problems and define required improvements for the design and control of operational processes (the IEM domain) at an academic level. Moreover, they are able to implement such improvements. The difference between BSc and MSc is, that BSc graduates are able to perform these activities in relatively simple cases, whereas MSc graduates are able to act adequately in more complex situations. This involves defining problems and research questions; describing intended results, scope of research and design efforts, available resources; determining the constraints for feasible solutions, from different perspectives (such as: organizational, legal, financial, ethical, professional norms) and for different stakeholders (such as: employees, shareholders, suppliers, local community, regulators); defining criteria for evaluating alternative solutions.
		MSc final qualifications
		The graduate is able to quickly identify, thoroughly comprehend, critically assess, correctly apply, and creatively integrate existing scientific knowledge that can be used for analyzing problems and designing solutions, in one of the domains of: * production and logistics; * finance and accounting; * health care
	A1	Has a thorough overview of the structure of research and design processes and is able to * identify the various steps in performed research and design * properly break up own research and design activities into sub-processes *These processes are intertwined: Research is needed for producing knowledge that is used for designing solutions in a specific context. Such knowledge is produced in a purposeful and methodical way (using scientific research methods). It may or may not be generalizable knowledge.*
	A2	Has an overview of quantitative and qualitative empirical research methods and is able to * critically analyze performed research as to the methodological aspects * select an appropriate method and justify this choice for research to be performed * apply this method in relatively complex cases
	A3	Has a thorough overview of quantitative modeling techniques for operational processes in this domain, and is able to * critically analyze the results of modeling activities * select appropriate modeling techniques and justify this choice * apply these techniques in relatively complex cases.
	A4	Is able to integrate existing knowledge, modeling techniques, and research results for designing, validating, and selecting solutions in relatively complex cases. *This is challenging, because existing knowledge may not fully apply to a specific situation, models are always stylized, empirical research always has limitations, and some aspects have been left out of scope from the beginning anyway.*
	A5	Has an overview of implementation methods and processes and is able to * critically analyze ongoing or finished implementation processes * plan globally an implementation process in a relatively complex case
	A6	Has an overview of evaluation methods and techniques and is able to * critically analyze the results of performed evaluations * select appropriate evaluation methods and justify this choice * carry out an evaluation in relatively complex cases
	A7	In order to be able to meet these competencies, the graduate must have mastered a set of core disciplines in the specialization domain.
	A8	Is able to contribute to the development of the academic profession by identifying generic consequences and implications from professional cases (for example, general presentations, write papers about design solutions).
		B. General academic qualifications
B: General academic		**MSc final qualifications**
	B1	Is able to work autonomously and self-reliant
	B2	Is able to work in multidisciplinary teams
	B3	Is able to communicate properly (in oral and written form) with various stakeholders
	B4	Is able to conduct a bibliographic search and knows how to reference correctly
	B5	Is able to reflect on professional behaviour and ethical and societal aspects of work
	B6	Is able to reflect on and direct personal and professional development
	B7	Is able to manage and concretize effectively his own learning process in the context of "life long learning"

APPENDIX 4: OVERVIEW OF THE CURRICULUM

Bachelor's programme Technische bedrijfskunde

Module overview:

Year 1	Year 2	Year 3
Module 1: Introductie Technische bedrijfskunde ('Introduction to IEM')	Module 5: Finance for Engineers	Module 9: Elective
Module 2: Operations Management	Module 6: Consumentenproducten ('Consumer product')	Module 10: Elective
Module 3: Business Intelligence & IT	Module 7: Van product design naar online business ('From product design to online business')	Module 11: Preparation thesis
Module 4: Supply Chain Management	Module 8: Processen modelleren en optimaliseren ('Modelling & analysis of stochastic processes IEM')	Module 12: Thesis

Table 1. Overview of modules in the BSc TBK program

N.B. All modules equal 15 EC; they are consecutively taught throughout the year – every quartile, students start a new module.

Learning lines overview (as incorporated in the various modules:

		4 x 15 EC modules per year												
		ECs in Year 1				ECs in Year 2				ECs in Year 3				Total ECs
Domain	**Production and Logistics Management**	1	7	0	9	0	12.5	2	8.5			1		41
	Financial Engineering and Management	2	0	V	0	12.5	0	1	0			1		16.5
	Information and Technology Management	3	0	8	0	0	0	3	0			1		15
Meth. & Tech.	**Mathematics**	4	3	0	3	0	0	3	0			0		13
	Statistics & Probabilities	2	0	4	3	0	0	0	6.5			0		15.5
	Methodology	1	0	2	0	2.5	0	1	0			2.5		9
	Business Administration	1	3	V	0	0	2.5	4	0			2.5		13
	Academic and professional skills	1	2	1	V	V	V	1	0			7		12
	Electives									15	15			30
	Graduation Project												15	15
		15	15	15	15	15	15	15	15	15	15	15	15	180
	Legend: V = Sufficient													

Table 2. High Level Learning lines BSc TBK program

Master's programme Industrial Engineering And Management:

<table>
<tr><th colspan="3">IEM (shared) mandatory courses:</th></tr>
<tr><td colspan="3">Introduction to Industrial Engineering and Management (5 EC)</td></tr>
<tr><td colspan="3">Statistics and Probability (5 EC)</td></tr>
<tr><td colspan="3">Data Science (5 EC)</td></tr>
<tr><th>Track FEM</th><th>Track PLM</th><th>Track HCTM</th></tr>
<tr><td>Micro Economics (5 EC)</td><td colspan="2" rowspan="2">Discrete Optimization of Business Processes (5 EC)</td></tr>
<tr><td>Mathematical Finance (5 EC)</td></tr>
<tr><td>Introduction to Risk Theory (5 EC)</td><td colspan="2">Simulation (5 EC)</td></tr>
<tr><td>Structured Products (5 EC)</td><td>Supply Chain & Transport Management (5 EC)</td><td>Optimization of Healthcare Processes (5 EC)</td></tr>
<tr><td>Risk Management (5 EC)</td><td>Advanced Production Planning (5 EC)</td><td>Health & Health Systems (5 EC)</td></tr>
<tr><td>Special Topics in Financial Engineering (5 EC)</td><td>Warehousing (5 EC)</td><td>Clinical Safety and Quality Assurance (5 EC)</td></tr>
<tr><td>Management Control for Financial Institutions (5 EC)</td><td rowspan="2">Management of Technology for PLM (5 EC)</td><td>E-health Strategies (5 EC)</td></tr>
<tr><td>Management of Technology for FEM (5 EC)</td><td>Management of Technology for Health Care (5 EC)</td></tr>
<tr><td>Electives (30 EC)</td><td>Electives (40 EC)</td><td>Electives (35 EC)</td></tr>
<tr><td colspan="3">Preparation Thesis (5 EC)</td></tr>
<tr><td colspan="3">Master Thesis (30 EC)</td></tr>
</table>

Students enrolling in September, start with the mandatory course work. Students enrolling in February, start with electives. All students in all tracks end with writing their master thesis.

APPENDIX 5: PROGRAMME OF THE SITE VISIT

DAY 1:	**WEDNESDAY OCTOBER 12, 2016**
09.00 – 9.15	Welcome by the Dean prof.dr.ir. T. Toonen
09.15 – 12.30	Preparation committee; Study of material and lunch
12:30 – 13:30	**Management** Meeting with Education Director and authors of the SER : Erwin Hans, Cornelis ten Napel, Bernadette Pol
13.30 – 14.00	Deliberation committee
14.00 – 14.45	**BSc students** Ruben van de Ven, Liza Snellen, Jade van Laar, Thijs Broekhuijsen, Darshana Jhinkoe-Rai en Jelle Kerkdijk
14.45 – 15.30	**MSc students** Joost Muis, Haya Adboul Nour, Peter Bartels, Anneloes Oude Weernink, Femke van der Putten, Michiel Barends
15.30 – 16.00	Break
16.00 – 17.00	**BSc and MSc lecturers** Brigit Geveling, Sandor Lowik, Leo van der Wegen, Berend Roorda, Jos van Hillegersberg, Hans Heerkens, Martijn Mes, Ahmad-Al-Hanbali
17.00 – 17.45	**MSc Alumni** Denise van Brenk, Laura van Silfhout, Berry Gerrits, Dirk Jonkman, Arno Willemink, Laura Hofman
DAY 2:	**THURSDAY OCTOBER 13, 2016**
08.00	**Panel at reception in Hotel De Broeierd**
08.30 – 09.00	**BSc Alumni** Bram Pijnappel, Danny Kuiper
09.00 – 09.30	**Programme committee (OLC)** Bas Hottenhuis, Tim Schuitema, Koos Sipma, Roel Gijzen, Maria Iacob (vz.), Martijn Mes, Sandor Löwik
09.30 – 10.00	Break
10.00 – 11.00	**Exam committee** Marco Schutten (vice Chair), Hans Heerkens, Tom Mulder (Secretary, i.a.)
11.00 – 12.30	Committee preparation final meeting with Education Management (incl. lunch)
12.30 – 13.30	**Final meeting management** Erwin Hans, Cornelis ten Napel en Bernadette Pol
13.30 – 16.00	Deliberation and preparation of preliminary conclusions
16.00 – 16.15	**Presentation of preliminary findings and end site visit** Faculty members and students

Participants, University of Twente

prof.dr.ir. T. Toonen, Dean Faculty of Management and Governance

Education management and (co-)authors of the SER

prof.dr.ir. E. W. (Erwin) Hans	Education director
ms. B. G.F. (Bernadette) Pol	Education coordinator
ir. C. (Cornelis) ten Napel	Study Counsellor

Bachelor students	**year of study**
Ruben van de Ven	2nd
Liza Snellen	2nd
Jade van Laar	3rd
Thijs Broekhuijsen	3rd
Darshana Jhinkoe-Rai	4rd
Jelle Kerkdijk	4rd

Master Students	**track**	**prior education**
Joost Muis	FEM	HBO-TBK
Haya Adboul Nour	FEM	BSc Electrical Engineering: Syria
Peter Bartels	HCTM	BMT-UT
Anneloes Oude Weernink	HCTM	TG - UT
Femke van der Putten	PLM	TBK-UT
Michiel Barends	PLM	TBK-UT

Lecturers/track coordinators

Drs. B.M. (Brigit) Geveling	BSc (Mathematics)
Dr. ir. S.J.A. (Sandor) Löwik	BSc (Academic and Professional skills)
Dr. J.M.G. (Hans) Heerkens	BSc (Methodology)
Dr. A. (Ahmad) Al-Hanbali	Module coordinator M4
Dr. B. (Berend)Roorda	Module coordinator M5 and FEM track coordinator
Prof.dr. J (Jos) van Hillegersberg	Module coordinator M7
Dr.ir. M. (Martijn) Mes	Module coordinator M8
Dr.ir. L. L.M.(Leo) van der Wegen	BSc/MSc-PLM track coordinator (interim HCTM track coordinator)

Alumni BSc/MSc	**track**		**employer**
Denise van Brenk	PLM	BSc TW	Vumc, Vreelandgroep, Consultant
Laura van Silfhout	PLM	BSc-TBK	Grolsch, Senior production planner
Berry Gerrits	PLM	BSc TBK	PhD Utwente
Dirk Jonkman	FEM	BSc TBK	just graduated
Arno Willemink	FEM	BSc TBK.	De Heus, trainee
Laura Hofman	HCTM	BSc GzW	HHM, Enschede, adviseur
Bram Pijnappel			Currently, MSc student (1st year)
Danny Kuiper			Currently, MSc student (1st year)

OLC student members

Bas Hottenhuis	3nd year BSc student
Tim Schuitema	4th year BSc student
Koos Sipma	1th year MSc student
Roel Gijzen	2nd year MSc student

OLC staff members

Dr.ir. (Maria) I.E. Iacob	chair
Dr.ir. (Sandor) S.J.A. Löwik	member
Dr.ir. (Martijn) M. Mes	member

Exam committee

Dr.ir. J.M.J. (Marco) Schutten	Member - TBK MSc committee (Vice-Chair)
Dr. J.M.G. (Hans) Heerkens	Member - TBK BSc committee
T.L.C.(Tom) Mulder, MA	Secretary i.a.

APPENDIX 6: THESES AND DOCUMENTS STUDIED BY THE PANEL

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

Bachelor's programme Technische bedrijfskunde

0095257	1227041	1248707
1235842	1247301	1364286
1229532	0023922	1115324
1258028	1231685	0144061
1127594	1231383	1009494

Master's programme Industrial Engineering And Management

1011650	0193585	1012487
1088637	0171875	1006770
0212563	0214280	1027808
1008730	1004913	1482289
1005413	1095633	1004824

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

Documents

Dashboard SAR, a digital addendum to the Critical Reflection. The SAR also included tables for 2013 and 2015 from the NAE/WO-monitor, as prepared by the Vereniging Samenwerkende Nederlandse Universiteiten.
Annual report Examination Board 2014-2015
Minutes Examination Board 2015-2016
Minutes Programme Board 2013-2014, 2014-2015 and 2015-2016
Information booklet on the Twents Onderwijs Model (TOM)
Information sheet on the Thesis Carousel

Course materials

TBK:
Module 3: Business Intelligence and IT
Module 7: From Product Design to Online Business
Module 8: Modelling and Analysis of Stochastic Processes for IEM
Module 11: Preparation Thesis
Cross programme material (skills and methods)

IEM:
Introduction to IEM
Management of Technology for IEM
Data Science
Thesis preparation
Advanced Production Planning