TECHNISCHE BESTUURSKUNDE

FACULTY OF TECHNOLOGY, POLICY AND MANAGEMENT

DELFT UNIVERSITY OF TECHNOLOGY

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REPORT ON THE BACHELOR'S PROGRAMME TECHNISCHE BESTUURSKUNDE OF DELFT UNIVERSITY OF TECHNOLOGY

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

ADMINISTRATIVE DATA REGARDING THE PROGRAMME

Bachelor's programme Technische bestuurskunde

Name of the programme:	Technische bestuurskunde
CROHO number:	56995
Level of the programme:	bachelor's
Orientation of the programme:	academic
Number of credits:	180 EC
Specialisations or tracks:	Built Environment & Spatial Development; Energy & Industry; Information & Communication; Transport & Logistics
Location(s):	Delft
Mode(s) of study:	full time
Language of instruction:	Dutch
Expiration of accreditation:	31-12-2017

The visit of the assessment panel Technische Bedrijfs- en Bestuurskunde to the Faculty of Technology, Policy and Management of Delft University of Technology took place on 12 and 13 December 2016.

ADMINISTRATIVE DATA REGARDING THE INSTITUTION

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

COMPOSITION OF THE ASSESSMENT PANEL

The panel that assessed the master's programme Systems Engineering, Policy Analysis and Management consisted of:

- Prof.dr ir. Rob van der Heijden, Radboud University Nijmegen [chair];
- Prof.dr. Harrie Eijkelhof, Utrecht University;
- Prof.dr. Arthur Petersen, University College London, United Kingdom;
- Prof.dr. Marcel Veenswijk, VU University Amsterdam;
- Prof.dr. Hens Runhaar, Wageningen University and Research & Utrecht University
- Maarten van Ruitenbeek, BSc, University of Groningen [student member].

The panel was supported by dr. Barbara van Balen, who acted as secretary. Appendix 1 contains the curricula vitae of the panel members.

WORKING METHOD OF THE ASSESSMENT PANEL

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

The project manager approached independent panel members based on the programmes' recommendations, taking into account the specialised tracks at the four institutions. The NVAO approved the panel composition on 10 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;
- Prof.dr Hens Runhaar, Wageningen University and Research & Utrecht 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. Prof.dr. Harrie Eijkelhof, an education expert with a long-standing academic career in the teaching of science, also 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. Calibration meetings took place on 15 December 2016 and 22 March 2017 between prof.dr.ir. Van der Heijden, prof.dr. Eijkelhof and both secretaries to attune the panels' findings to assure consistency of the assessments within the cluster.

Site visit TU Delft

Preparation
To prepare for the assessment, the management provided a critical reflection on the bachelor's programme. In them, 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 also selected 15 bachelor theses, covering the full range of marks given, a range of thesis subjects, and representing the various examiners.

Site visit
A site visit to the Faculty of Technology, Policy and Management at TU Delft took place on 12 and 13 December 2016 in the presence of all six 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 the programme. For the timetable 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 with an 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 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 incorporated accordingly. Subsequently, the programme checked it for factual irregularities. Comments by the programme were discussed by the secretary and chair and, where necessary, other panel members before the report was finalised.

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 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

Standard 1
The bachelor's programme Technische bestuurskunde (TB) offered by the Faculty of Technology, Policy and Management of Delft University of Technology (TU Delft) teaches students to analyse systems that are technically, socio-economically and politically complex. The purpose of the programme is to enable students to become analysts of socio-technological systems and to make them eligible for a range of master's programmes. The general learning outcomes have been elaborated in well-defined, detailed learning outcomes, which meet the Dutch qualifications framework and tie in with the international perspective of the requirements set by the professional field and the discipline. The focus of the TB bachelor's programme on large-scale systems that have a strong impact on society is unique for the Netherlands and is difficult to benchmark internationally. In particular, the emphasis on modelling as an important analysis tool is a specific characteristic of the TB bachelor's programme.

Standard 2
The TB bachelor's curriculum is a combination of science, engineering, social and behavioural disciplines. It is structured in four clusters: Analysis of Complex Socio-Technical Systems, Governance of Complex Socio-Technical Systems, Mathematical Modelling, and Technology Specialisation in one of the following fields: Built Environment & Spatial Development, Energy & Industry, Information & Communication, or Transport & Logistics. In the third year of the curriculum, students follow a minor, which allows them to study abroad. Students complete their studies with a bachelor's project.

The panel has two points of concern which have been brought forward and recognised by the programme management: the high intake of students with a high dropout rate during the first year and the overall study yield. The panel recommends introducing a better matching tool for prospective students and active monitoring of the effectiveness of the measurements aimed at improving the study yield.

The structuring in clusters guarantees a good balance between the subjects covered in the curriculum. The panel is positive about the innovative way the teaching staff is developing a blended learning environment and encourages the programme management to enable further development and implementation of the combination of online teaching methods and computer learning with intensive face-to-face contact. It established that the content and structure of the TB bachelor's programme enable the students to achieve the intended learning outcomes.

Standard 3
The Faculty of Technology, Policy and Management (TPM) described its assessment policy in the Assessment Policy 2013-2014 document. The panel studied a selection of test dossiers and bachelor's theses and the accompanying assessment forms. Furthermore, it held a meeting with the Board of Examiners during the site visit. It verified that the programme has an adequate assessment system. The assessments are valid, transparent and reliable. The Board of Examiners is performing its legally mandated tasks adequately. The panel sees some risks in the preference of the Board of Examiners for an advisory instead of a more controlling position and recommends that it strengthen its independent position to guarantee the quality of the examinations.

Standard 4
The panel established that all learning outcomes are covered in the bachelor's curriculum and concluded that graduates have achieved all learning outcomes before they are allowed to graduate. It studied a selection of 15 bachelor's project reports to assess whether the graduates had achieved the bachelor's graduation level. It concluded that the graduates had demonstrated that they had achieved the level that can be expected from an academic bachelor. It found the bachelor's projects to be adequate.

The panel established that the bachelor's programme prepares students well for the Faculty's master's programmes. In addition, there were no indications that students who continued their studies elsewhere had difficulties with the transition or felt ill prepared. Hardly any graduate took up a job on the labour market rather than go on to do a master's programme.

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

Bachelor's programme Technische bestuurskunde

Standard 1: Intended learning outcomes	good
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 it. They confirm that the assessment has been conducted in accordance with the demands relating to independence.

Date: 28 March 2017

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

dr. B.M. van Balen

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

The bachelor's programme Technische bestuurskunde is offered by the Faculty of Technology, Policy and Management at Delft University of Technology. The Technische bestuurskunde curriculum was started in 1992. In 2001, following the Bologna agreements, the programme was divided into a bachelor's and a master's programme.

The Faculty offers three master's programmes alongside the bachelor's programme: Engineering and Policy Analysis; Systems Engineering, Policy Analysis and Management; and Management of Technology. The assessments of these master's programmes are described in separate reports.

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
The bachelor's programme Technische bestuurskunde (TB) teaches students to analyse systems that are technically, socio-economically and politically complex. Its purpose is to enable students to become analysts of socio-technological systems and to make them eligible for a range of master's programmes.

The critical reflection states that graduates of the bachelor's programme are analytically able to:
- determine which factors within complex socio-technical systems are relevant for the respective actors within these systems;
- explain the values of these factors for the institutional and technical structures and processes within these systems, and the surroundings of these systems;
- reason how these processes and factors (their values) will change as a result of changes in the institutional or technical structures of these systems;
- evaluate which decision-making dilemmas actors within these systems face.

'Institutional structures' is understood to mean: systems of formal and informal rules that determine the behaviour of actors.

The graduates have specific knowledge in at least one of four domains:
  - built environment of spatial development;
  - energy & industry;
  - information & communication;
  - transport & logistics.

These general learning outcomes have been elaborated in 51 detailed intended learning outcomes (Appendix 3). The 2010 Assessment Panel had recommended reformulating the intended learning outcomes. The current panel appreciated that the programme management reacted actively to this recommendation and was impressed by the thorough translation of the mission and objectives of the programme. The intended learning outcomes are transparent and informative and indicate what could be expected from a programme at the bachelor's level. For example, the general competence 'Analysing' is elaborated in six intended learning outcomes. The panel is of the opinion that the intended learning outcomes also indicate a high level of ambition. This can be illustrated by the following ones:

- 10. Is able to reformulate ill-structured research problems. Also takes account of the system boundaries in this. Is able to defend the new interpretation against involved parties.
- 28. Is able to document adequately the results of research and design with a view to contributing to the development of knowledge in the field and beyond.

The intended learning outcomes fit the Domain-Specific Framework of Reference developed by the Dutch programmes for Industrial Engineering and Management. The panel ascertained that the intended learning outcomes meet the internationally accepted standards for academic bachelor's programmes, the Dublin descriptors. The programme management specified in the critical reflection that the learning outcomes were reformulated in accordance with the Meijers Criteria[1], as was advised by the 2010 assessment committee.

The focus of the TB bachelor's programme on large-scale systems that have a strong impact on society is unique for the Netherlands and difficult to benchmark internationally. In particular, the emphasis on modelling as an important analysis tool is a specific characteristic of the TB bachelor's programme. Students consider the linking of the programme to the major issues current in society in combination with the basic knowledge of technology to be distinctive.

Considerations
The panel considers it very positive that the TB bachelor's programme has a distinctive focus on large-scale systems with an emphasis on modelling as a tool. It clearly recognises the added value of the combination of engineering, social sciences and management. This is a unique programme in the Netherlands and is also recognised as such by students. International peers also value the programme because of its unique profile. The panel greatly appreciates that the general learning outcomes have been elaborated in well-defined, detailed learning outcomes.

The panel concluded that the intended learning outcomes meet the Dutch qualifications framework and tie in with the international perspective of the requirements set by the professional field and the discipline.

Conclusion
The panel assesses Standard 1 as 'good'.

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
The bachelor's curriculum of Technische bestuurskunde is a combination of science, engineering, and social and behavioural disciplines. It consists of modules of 5 EC, three of which run in parallel in each period. The modules are structured in four clusters:

- Analysis of Complex Socio-Technical Systems (25 EC)

[1] The Meijers' Criteria were specifically developed for degree programmes of the Universities of Technology to supplement the Dublin descriptors. Meijers, A.W.M., C.W.AM. van Overveld & J.C. Perrenet (2005), Academic Criteria for Bachelor and Master Curricula, TU Delft, TU/e & University of Twente.

- Governance of Complex Socio-Technical Systems (35 EC)
- Mathematical Modelling (45 EC)
- Technology Specialisation (30 EC).

In the third year, students follow a minor (30 EC) and complete their studies with a bachelor's project. The courses of the first three clusters are taken by all students together and deal with generic methods for socio-technical problems. In addition to these generic clusters, students follow a Technology Specialisation in one of four fields:
- Built Environment & Spatial Development;
- Energy & Industry;
- Information & Communication;
- Transport & Logistics.

Several modules contain projects in which theoretical notions are applied to cases. Most projects are carried out in groups. The training of skills is integrated into the modules with a most natural fit for those skills (an overview is included in Appendix 4). The panel finds it positive that skills training is an integral part of the curriculum and connected to the content. The appendices to the critical reflection contain a matrix of the intended learning outcomes and course objectives, which clearly indicates that the attainment of skills is a substantial part of the curriculum.

The content of the programme is in line with its multidisciplinary focus. The structuring into clusters makes the learning lines in the programme transparent and assures that all subjects are covered. The clusters cover aspects of management, economics and law, and mathematical modelling and statistics. The programme prepares the students for achieving the intended learning outcomes.

The Technology Specialisations enable the students to develop a basic knowledge of and insight into technology. The students appreciate this approach. Some students extend their technology expertise by taking an extra technology minor. The four technology fields are not all of the same quality, however. According to the panel, the field that was introduced last in the programme, 'Built Environment & Spatial Development', is strongly focused on issues of spatial development. As a result, the technical complexity of this specialisation seems underdeveloped compared to the other three specialisations. The panel suggests switching the focus in this domain to the major challenges in the built environment regarding sustainable building, including issues such as the planned energy transition, functional transformation of existing buildings, and reuse and recycling of materials.

The students mentioned in the interview that they find the TB programme distinctive due to the combination of its focus on society, the basic knowledge of technology, and the knowledge and insight into governmental processes in the Netherlands. The panel is of the opinion that the curriculum is a good representation of the programme's ambitions.

The curriculum pays ample attention to the development of academic skills and research expertise. Several courses are specifically dedicated to the development of research expertise and skills: Operational Research, Research Methods & Data Analysis, Philosophy of Science & Ethics. The results of the NSE[2] indicated that the students value the attention paid to the development of research expertise and skills in the programme. The programme scores above average on this aspect. According to the panel, the students showed in their bachelor's projects that they are well prepared to structure a complex problem situation, to establish what research questions such a situation could lead to, to answer the questions based on a systematic application of methods of analysis, and to interpret the research results consistently, which are the objectives of the bachelor's project.

[2] NSE, Nationale Studenten Enquete (National Student Survey) performed by Studiekeuze 123 for the Ministry of Education, Culture and Sciences.

The programme management describes the didactical principles of the bachelor's programme as:
- authentic learning situations;
- theory before practice;
- blended learning.

These principles are indeed visible in the classroom. Teaching staff use examples from their own research in class. Furthermore, guest lectures by experts working in the industry or governmental organisations are frequently scheduled, and contacts are fostered with external parties. The students confirmed that the usual method in class is theory before practice. The panel noted that experiments with blended learning have been introduced and received information about MOOCs and the way these online lectures are used in on-campus teaching. The usual method in blended courses is that information is given online, either as video lectures or short presentations, PowerPoint presentations, knowledge clips or instructions. This information is followed by a study group meeting with a question and answer session and a discussion and application session. The students appreciate this way of working but are not in favour of replacing all lectures with online information. The face-to-face contact with teachers remains necessary and valuable in their view. The panel is positive about the proactive way the Faculty is developing blended learning experiments and is interested in the progress the Faculty is making. It is too early to speak of a real blended learning environment, but some of the experiments are promising. The panel also noted that the Faculty is evaluating the experiments thoroughly, which has already resulted in a more balanced use of video lectures to ensure that the students also have sufficient direct contact with the best teachers. The relative lack of direct contact was one of the issues brought forward by the students in some course evaluations.

The panel appreciates that the curriculum leaves room for a minor in the first half of the third year. The students can also use this period to study abroad, which is strongly encouraged, and some of the students take advantage of that opportunity. Students reported that the support and facilities for studying abroad are organised at a university-wide level. These facilities are very much appreciated by the students. They feel encouraged and supported to do part of their studies abroad. Internationalisation is a fact in Delft. Students from abroad find their way easily to TU Delft and its degree programmes, and vice versa is also true.

Since all staff members of the Faculty are involved in all degree programmes, it is not possible to give a student-staff ratio for one of the programmes. The critical reflection presents a student/staff ratio of 21.3 for the whole Faculty. The panel noted that the staff is really involved with teaching and coaching and is accessible to the students. Their doors are open, and staff and students are frequently present in the Faculty building. The quantity and quality of the staff in general are both sufficient. All members of the teaching staff are UTQ (University Teaching Qualification) qualified or are busy taking the courses needed for the qualification. All members of the teaching staff hold a master's degree and are tenured, and almost all module managers have PhDs. Some 80% of the teachers fulfil the English language proficiency requirements. The quality of the teaching is regularly monitored. An essential component of this monitoring is to ask students their opinions after all courses. After each evaluation, the teachers reflect on the outcomes and propose improvement measures.

A point of concern for the panel is the high intake and high drop-out rates of students in the first year. The programme management explained that there is a high intake of students who received a negative BSA (Binding Study Advice) at the end of their first year in other TU Delft bachelor's programmes. These students made a late switch to Technische bestuurskunde and appear insufficiently informed about the content and level of the programme. The programme management remarked that it is not easy to contact this specific group. They may not even participate in lectures. The panel, nevertheless, recommends investigating this situation more thoroughly and developing a better matching tool for candidates, even for these late switchers, to avoid wrong study choices. The matching tool that Utrecht University introduced recently seems to work very well.

The study yield of the bachelor's programme is improving, according to the presented data, but still needs attention. The presented data indicate that 50% of the 2002 cohort that re-registered in the second year graduated in six years, as did 82% of the 2009 cohort. However, only 18% of the students graduates within three years. The programme management reported that several measurements have been implemented to improve the study yield, such as the introduction of blended learning and digital exams and the rule that exams should be assessed within 10-20 days. The panel is positive about these measurements, but could not yet establish their effectiveness.

The panel toured the Faculty building and established that the study environment is very stimulating. Students have ample room and facilities to study, to cooperate in study groups and to meet each other and their teachers. They are actively involved in the programme. Each degree programme of the TPM Faculty has its own Board of Studies (BoS), on which both teachers and students participate. The BoS monitors the quality of the teaching and advises on matters relevant to the programme. Members of the faculty-wide study association participate on the Faculty board and the BoS and actively contribute to the process of evaluation and improvement of the programme. The study association also organises excursions to industry and lectures by representatives of the work field.

Considerations
The panel established that the content and structure of the TB bachelor's programme enable the students to achieve the intended learning outcomes. It assessed the content, the coherence, the teaching methods and the feasibility of the programme, as well as the quantity and quality of the teaching staff.

The structuring in clusters guarantees a good balance between the subjects covered in the curriculum, although the panel recommends reassessing this balance in the Built Environment & Spatial Development specialisation to bring this field up to the same level of technical quality as the other fields. The panel is positive about the innovative way the teaching staff is developing a blended learning environment and encourages the programme management to enable further development and implementation of the combination of online teaching methods and computer learning with intensive face-to-face contact. It greatly appreciates that the curriculum leaves room for a minor of 30 EC, which also creates the possibility for students to study abroad.

The quality of the teaching staff is good. The teaching staff is accessible and creates a good learning environment for the students, supported by the facilities of the Faculty building.

There remain two points of concern which have been brought forward and recognised by the programme management: the high intake and high dropout rate during the first year and the overall study yield. The panel recommends introducing a better matching tool for candidate students and active monitoring of the effectiveness of the measurements aimed at improving the study yield.

Conclusion
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 Faculty of Technology, Policy and Management (TPM) has described its assessment policy in the Assessment Policy 2013-2014 document. The document describes the current and the desired situation with regard to the roles and tasks of several bodies in the Faculty. The Faculty's assessment policy has evolved during the assessment period and now includes measures concerning the transparency, validity and reliability of assessment.

Transparency of assessment is achieved by course guides providing the necessary information about examinations and the availability of examples of earlier exams. The validity is achieved by peer-reviewed preparation of exams and the use of assessment plans for each module. Reliability is achieved by having a graduation committee of three staff members assess the theses and by using plagiarism detection programmes.

The panel studied a selection of test dossiers and of bachelor's theses and the accompanying assessment forms. It met with the Board of Examiners during the site visit. It established that the Faculty has an adequate assessment policy in place.

According to the panel, the Board of Examiners (BoE) is performing its legally mandated tasks adequately. During the site visit the BoE presented a clear vision of its role to the panel. The BoE chair explained that the BoE doesn't have the ambition to check every examiner and every teacher, but prefers to take an advisory position. The panel sees some risks in this position and recommends the BoE to pay attention to the prescribed independence of the BoE.

For the assessment of the bachelor's project, assessment templates have been drawn up. The first phase of the project involves writing an issue paper containing relevant research questions. In the second phase, students conduct their analysis. For the issue paper, two templates (a rubric and a descriptive template) are available. For the report that is the outcome of the second phase, an assessment template must be used. The BoE checks regularly whether or not the assessment templates have been used and advises the examiners to motivate their assessment. The rule that assessments always have to be done by more than one examiner (the four eyes principle) has been fully implemented throughout the Faculty. The BoE monitored this process. The panel recommends that the BoE also monitors the quality of the bachelor's project on a regular basis by evaluating samples of these projects.

Considerations
The panel established that the Faculty of Technology, Policy and Management of TU Delft has an adequate assessment system. The assessments are valid, transparent and reliable. The Board of Examiners is performing its legally mandated tasks adequately.

Conclusion
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
The programme management informed the panel in advance that the bachelor's project does not cover all intended learning outcomes of the bachelor's programme. However, the projects give a good indication of the level that is achieved by the students. In the appendices to the critical reflection, the programme provided an overview of the intended learning outcomes versus course objectives. The panel established that all learning outcomes are covered in the curriculum and concluded that graduates have achieved all of the learning outcomes before they are allowed to graduate.

The panel studied a selection of 15 bachelor's project reports from both phase one, the issue paper, as well as phase two, the research performed, to assess whether the graduates had achieved the intended learning outcomes (an overview is included in Appendix 6). It concluded that the graduates had achieved the level that can be expected from an academic bachelor's programme. It found the bachelor's projects to be adequate. The issue papers indicated sufficiently that the students are able to present a specification of a socio-technical problem, prepare a technological as well as a policy analysis of the problem, and formulate a relevant research question. The research reports indicated sufficiently that the students are able to produce and execute a research plan and write a structured report about the research and the results. They demonstrated adequately that the students are also able to critically reflect on the research results and their own actions.

The alumni of the bachelor's programme felt well prepared for the master's programmes offered by the Faculty. The panel established that the bachelor's programme prepares students well for the respective master's programmes: there were no indications that students who continued their studies elsewhere, or in other master's programmes at TU Delft, had difficulties with the transition or felt ill prepared. Hardly any graduate took up a job instead of going on to a master's programme, so no information is available about the relevance of the programme for the labour market.

Considerations
The panel concludes that the graduates of the bachelor's degree programme Technische bestuurskunde have achieved the intended learning outcomes. The level of the graduation projects concurs with that expected for an academic bachelor's programme. Graduates felt well prepared for the master's programmes.

Conclusion
The panel assesses Standard 4 as 'satisfactory'.

GENERAL CONCLUSION

The panel assessed standard 1, Intended learning outcomes, as good. The intended learning outcomes have been specified in concrete terms of content, level and orientation; they meet international requirements. The panel was very positive about the distinctive focus of the programme on large-scale systems that have a strong impact on society. In particular, the emphasis on modelling as an important analysis tool is a specific characteristic of the programme. The panel greatly appreciated that the general learning outcomes are elaborated in well-defined and detailed learning outcomes. Standard 2, The teaching-learning environment, was assessed as satisfactory. The panel established that the curriculum, staff and programme-specific services and facilities enable the incoming students to achieve the intended learning outcomes. The panel assessed standard 3, Assessment system, as satisfactory. The Faculty has an adequate assessment policy, and the Board of Examiners is performing its legally mandated tasks. Standard 4, Achieved learning outcomes, was assessed as satisfactory. The panel concluded that the graduates had achieved the intended learning outcomes.

Considering the assessments of the four criteria for the bachelor's programme Technische bestuurskunde, the panel assesses the programme as satisfactory.

Conclusion
The panel assesses the *bachelor's programme Technische bestuurskunde* 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 Civil 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 Scientific Director of the Institute of Management Research and Vice-Dean of Research at the Nijmegen School of Management (NSM). He was Dean of the Nijmegen School of Management from 2011-2016. Since June 2016, he has been 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

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 the 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.

Professor Arthur Petersen joined the Department of Science, Technology, Engineering and Public Policy at University College London full-time in September 2014 after more than thirteen years' work as scientific adviser on environment and infrastructure policy with the Dutch government. Additionally, he is Professorial Fellow at the Dutch National Institute for Public Health and the Environment – RIVM (since April 2016) and Research Affiliate at the Massachusetts Institute of Technology (since 2009). From 2011-2016, he was Adjunct Professor of Science and Environmental Public Policy at VU University Amsterdam. Professor Petersen studied Physics and Philosophy, obtained doctorate degrees in Atmospheric Sciences at Utrecht University (1999) and in the Philosophy of Science at VU University Amsterdam (2006). He now conducts research in Anthropology and Political Science. Most of his research focuses on managing uncertainty.

Maarten van Ruitenbeek, BSc (student member) is a first-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. He completed his bachelor in Industrial Engineering and Management Science at the University of Groningen in 2016. In 2015-2016, he was president of TBV Lugus, the student association of Industrial Engineering and Management in Groningen.

Professor Hens Runhaar is a Special Professor of Management of Biodiversity in Agricultural Landscapes at Wageningen University and Research and an Associate Professor of Environmental Governance at the Copernicus Institute of Sustainable Development at Utrecht University. The integration of environmental objectives into sectoral policies, planning and practices is his main area of interest. Dr Runhaar has researched this subject in various domains – such as transport, urban planning, natural resource management and, more recently, agriculture – encompassing environmental themes such as climate change mitigation and adaptation, environmental health and biodiversity. Other subjects addressed in his research are science-policy interactions, the framing of environmental problems and the consequences of these framings – including governance practice, effectiveness, and controversies. He has published over fifty scientific papers and (co)edited three special journal issues, most recently a special issue on coastal management for *Environmental Science and Policy*.

Professor Marcel Veenswijk is Full Professor in Management of Cultural Change at VU University Amsterdam. Professor Veenwijk graduated from the University of Leiden with a degree in Public Administration and holds a PhD from Erasmus University Rotterdam. He has worked as a researcher, lecturer and research manager. He has published widely on cultural change, institutional transformation and innovation processes, especially in the context of public sector organisations. The work of his current research group addresses the tensions between institutionalised structures and individual agency, the changing norms in institutional fields, the establishment of newly emerging fields, the breakdown or cut across institutionalised boundaries, and the micro-processes of conflict and identity formation. In addition to his scientific work, he has extensive experience as a consultant. Prior assignments included projects for ABN AMRO, Rijkswaterstaat, ProRail, the City of Amsterdam, Enexis, ING, KLM and several ministries.

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.[3] 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

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

scope of design thus may include supply chain networks, production and manufacturing techniques, products, control of 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 bestuurskunde

General
Graduates of the Bachelor's StudiesTechnische bestuurskunde are able to analytically:

- determine which factors within complex socio-technical systems are relevant for the respective actors within these systems;
- explain the values of these factors from the institutional and technical structures and proce sses within these systems, and the surroundings of these systems;
- reason how these processes and (values of) factors will change as a result of changes in the institutional or technical structures of these systems;
- reason which decision-making dilemmas actors within these systems face.

The analyses are performed in a well-structured and substantiated way on the basis of carefully underpinned selection of models and results.

The student has specific knowledge in at least one of the following technological domains:

- Built environment & Spatial development
- Energy & Industry
- Information & Communication
- Transport & Logistics

Knowledge and Skills

Competent in one or more Scientific Disciplines

1. Understands the knowledge base and methodology of the interdisciplinary field ofTechnische bestuurskunde, which aims at the analysis and management of complex socio-technical systems.
2. Can apply this knowledge to complex sociotechnical problems in one of the following technological domains: Built environment & Spatial development, Energy & Industry, Information & Communication, and Transport & Logistics, and can adequately communicate with experts from the domain concerned.
3. Understands the structure of the relevant fields, and the connections between sub-fields, in particular systems analysis, mathematical modelling, policy analysis, institutional economy, law and the technological domains mentioned.
4. Has insight in the way in which decision-making takes place by actors relevant in these fields.
5. Has insight in and some skill in the way in which truth-finding and the development of theories and models take place in the relevant fields.
6. Has insight in and some skill in the way in which interpretations (of texts, data, problems, results) take place in the relevant fields.
7. Has insight in and some skill in the way in which experiments, gathering of data and simulations take place in the relevant fields.
8. Is aware of both the presuppositions of the standard methods and their importance.
9. Is able (with supervision) to spot gaps in his / her own knowledge, and to revise and extend it through study.

Competent in doing Research

10. Is able to reformulate ill-structured research problems. Also takes account of the system boundaries in this. Is able to defend the new interpretation against involved parties.
11. Is observant, and has the creativity and the capacity to discover in apparently trivial matters certain connections and new viewpoints.
12. Is able (with supervision) to produce and execute a research plan.
13. Is able to work at different levels of abstraction.

14. Understands that an interdisciplinary approach is essential for a good analysis of socio-technical systems.
15. Is aware of the changeability of the research process through external circumstances or advancing insight.
16. Is able to assess research within the discipline on its usefulness.
17. Is able (with supervision) to contribute to the development of scientific knowledge in one or more areas of the disciplines concerned.

Competent in Analysing

18. Is able to reformulate ill-structured problems. Also takes account of the system boundaries in this. Is able to defend this new interpretation against the parties involved.
19. Is able to formulate the relevant system levels for an ill-structured problem, and choose appropriate abstraction levels.
20. Understands, where necessary, the importance of other disciplines (interdisciplinarity).
21. Is aware of the changeability of decision-making processes through external circumstances or advancing insight.
22. Is able to integrate existing knowledge in an analysis.
23. Has the skill to make methodological choices, and to justify and evaluate these in a systematic manner.

A Scientific Approach

24. Is inquisitive and has an attitude of lifelong learning.
25. Has a systematic approach characterised by the development and use of theories, models and coherent interpretations.
26. Has the knowledge and the skill to use, justify and assess as to their value models for research (model understood broadly: from mathematical model to scale model). Is able to create models for his or her own use.
27. Has insight into the nature of science and technology (purpose, methods, differences and similarities between scientific fields, nature of laws, theories, explanations, role of the experiment, objectivity etc.).
28. Is able to document adequately the results of research and design with a view to contributing to the development of knowledge in the field and beyond.

Basic Intellectual Skills

29. Is able (with supervision) to critically reflect on his or her own thinking, decision making, and acting and to adjust these on the basis of this reflection.
30. Is able to reason logically within the field and beyond; both 'why' and 'what-if' reasoning.
31. Is able to recognise modes of reasoning (induction, deduction, analogy etc.) within the field.
32. Is able to ask adequate questions, and has a critical yet constructive attitude towards analy sing and solving simple problems in the field.
33. Is able to form a well-reasoned opinion in the case of incomplete or irrelevant data.
34. Is able to take a standpoint with regard to a scientific argument in the field.
35. Possesses basic numerical skills, and has an understanding of orders of magnitude in the chosen technology specialisation.

Competent in Co-operating and Communicating

36. Is able to communicate in writing about the results of learning, thinking and decision making with colleagues and non-colleagues.
37. Is able to communicate verbally about the results of learning, thinking and decision making with colleagues and non-colleagues.
38. Is able to debate about both the field and the place of the field in society.
39. Is characterised by professional behaviour. This includes: drive, integrity, commitment, accuracy, perseverance and independence.

40. Is able to perform project-based work: is pragmatic and has a sense of responsibility; is able to deal with limited sources; is able to deal with risks; is able to compromise.
41. Is able to work within an interdisciplinary team.
42. Has insight into, and is able to deal with, team roles and social dynamics.

Takes Account of the Temporal and Social Context

43. Is able to analyse and to discuss the social consequences (economical, social, cultural) of new developments in relevant fields with colleagues and non-colleagues.
44. Is able to analyse the consequences of scientific thinking and acting on the environment and sustainable development.
45. Is able to analyse and to discuss the ethical and the normative aspects of the consequences and assumptions of scientific thinking and acting with colleagues and non-colleagues.
46. Has an eye for the different roles of professionals in society.

APPENDIX 4: OVERVIEW OF THE CURRICULUM

Bachelor's programme Technische bestuurskunde 2016-2017

First period	Second period	Third period	Fourth period

First year

P Problem analysis Project management & presenting	P Systems Modelling 1 Library Skills 1	Agent-Based Modelling	P Systems Modelling 2 Library Skills 2 & Reporting
Calculus & Differential Equations	Linear Algebra & differential Equations	Statistics & Data Analysis	Operational Research
Governance & Law 1	Micro & Market Economy	Technology Specialisation 1	Technology Specialisation 2

Second year

Technology Specialisation 3	Technology Specialisation 4	P Analysis of Multi-Actor Systems	Technology Specialisation 5
Economics of Infrastructure Finance	Governance & Law 2	Organisation & Management	P Governance of Socio-Technical Systems Interviewing
P System Dynamics	P Research Methods & Data Analysis	P Discrete Simulation Advising	Multivariate Data Analysis

Third year

Minor		Governance Specialisation	Philosophy of Science & Ethics Debating
		Technology Specialisation 6	Bachelor's Project
		Bachelor's Project	

Learning lines
Analysis of Complex Socio-technical Systems
Governance of Complex Socio-technical Systems
Mathematical Modelling
Technological Specialisation
P= Project Component
Skills

APPENDIX 5: PROGRAMME OF THE SITE VISIT

Programme site visit degree programmes 12 and 13 December 2016

Location: Faculty of TPM Jaffalaan 5 2628 BX Delft

Monday 12 December 2016

8.15 Arrival of audit committee

8.15-8.30 Welcome

Mr Prof.dr. T.S. (Theun) Baller	Dean TPM
Mr Prof.mr.dr. E.F. (Ernst) ten Heuvelhof	Director of Education TPM

8.30-9.00 Preparatory meeting committee

09.00-10.00 Education management team (EMT)

Mr Prof.mr.dr. E.F. (Ernst) ten Heuvelhof	Director of Education TPM
Mr Dr.ir. I. (Ivo) Bouwmans	Director of Studies TB
Ms Dr.ir. Z. (Zofia) Lukszo	Director of Studies SEPAM
Mr Dr.ir. B. (Bert) Enserink	Director of Studies EPA
Mr Dr. R.M. (Robert) Verburg	Director of Studies MOT
Ms Drs. J.K. (Jenny) Brakels	Manager Education &Student Affairs
Mr M.A. (Mathijs) Bijkerk BSc	Commissioner MSc Curius
Ms C.A. (Elsemiek) Smilde	Commissioner BSc Curius

10.00-10.30 Meeting audit committee (incl. break)

10.30-11.00 Students B Technische bestuurskunde (TB)

Ms M.M.G.C. (Menghua) Prisse	1st year
Mr P.X. (Pepijn) Thijssen	2nd year; Commissioner Bachelor Education FSC TPM 2016-2017
Ms A.C. (Claire) Post	2nd year
Ms M. (Mira) Groot	3rd year
Mr. J.B. (Jelle) van der Lugt	3rd year
Mr A.P. (Toon) Jansen	4th year

11.00-11.30 Students M Systems Engineering, Policy Analysis and Management (SEPAM)

Ms I. (Inés) Martínez Bustamante	1st year; BSc international
Mr J. (Joris) Zwijnenburg	1st year; BSc TB
Ms. L. (Leonie) Vogelsang	1st year; BSc TB
Mr Á.A. (Álvaro) Papic González	2nd year, BSc International
Mr S.F. (Stephan) Kool	3rd year; BSc TB
Ms F.C. (Fransje) Oudshoorn	3rd year; BSc TB

11.30-12.15 Lecturers B TB and M SEPAM

Ms Dr.ir. C. (Els) van Daalen	Associate professor, Systems Dynamics and Systems Modelling
Mr Dr. J.A. (Jan Anne) Annema	Assistant professor, Transport Policy
Ms Dr.ir. P.W. (Petra) Heijnen	Assistant professor, Energy & Industry
Mr Dr.ir. L.J. (Laurens) de Vries	Associate professor, Energy economics and regulations
Dhr. Dr. S (Stephan) Lukosch	Associate professor, Design Methodologies, requirements engineering, collaboration
Dhr. Dr. H. (Haiko) van der Voort	Assistant professor, Organisation science, process management, regulation
Mr Ir. H.W. (Herman) de Wolff	Assistant professor, Land development
Mr Prof.dr.ir. M.F.W.H.A. (Marijn) Janssen	Full professor, ICT

12.15-14.30 Meeting audit committee (incl. lunch)

14.30-15.00 Students M Management of Technology

Ms. A.F. (Lieke) van den Eijnden	1st year, BSc Life Science & Technology
Ms S. (Silvia) Fernandez Gelonch	1st year, BSc Industrial Technologies Engineering
Mr A.D.B. (Abe) Scholte	1st year; BSc Industrial Design Engineering
Ms P.D.L.A. (Pamela) Nunez Araya	2nd year; BSc Electromechanical Engineering
Mr J.A. (Juan) Carvajal Rodriguez	2nd year; BSc international
Mr M.A. (Misha) Grift	2nd year; BSc HBO, Commissioner MOT education FSC TPM 2016-2017

15.00-15.30 Lecturers M Management of Technology

Mr Prof.dr.ir. M.F.W.H.A. (Marijn) Janssen	Full professor, e-government, business processes
Ms Dr. H.K. (Heide) Lukosch	Assistant professor, Participatory systems, augmented reality
Mr Dr. J.R. (Roland) Ortt	Associate professor, Breakthrough technologies, innovation management
Mr Prof.dr. C.P. (Cees) van Beers	Full professor, Frugal innovations, developmental economics, innovation management
Mr Dr. G. (Geerten) van de Kaa	Assistant professor, Business strategy, standardisation

15.30-17.00 Meeting audit committee (incl. break)

17.00- 17.30 Alumni

Ms J.E.L. (Joke) Blom BSc	BSc TB, student MSc Transport, Information and Logistics

Mr T.T. (Tim) Romijn BSc	BSc TB, student MSc Engineering and Policy Analysis
Mr Y. (Yi) Yin MSc	MSc SEPAM, PhD student at ICT, VRE4EIC project
Ms ir. D.M. (Diana) Vonk Noordegraaf	MSc SEPAM, PhD TRAIL, Consultant at TNO
Ms ir. K.K. (Kaveri) Iychettira	MSc EPA, PhD student at SETS Joint Doctorate on Energy Policy at TU Delft, KTH Stockholm and Comillas, Madrid
Mr J. (Jerome) Vincendon MSc	MSc MOT; Technical Consultant at Gen25
Mr A. (Amir) Piltan MSc	MSc MOT; PTech B.V., Owner and Director

19.00-21.30 Diner audit committee

Tuesday 13 December 2016

8.15 Arrival of audit committee

8.30-9.00 Preparatory meeting committee (optional: walk-in hour)

9.00-9.30 Students M Engineering and Policy Analysis

Ms I.M. (Isabelle) van Schilt	1st year; BSc TB, Commissioner EPA education FSC TPM 2016-2017
Ms M.B.C. (Marijne) Kramer	1st year, BSc TB
Mr J.C. (Jasper) Meijering	1st year, BSc TB
Mr G.P.S. (Gurvinder) Arora	1st year, Bachelor of Technology in Mechanical Engineering
Mr J.P. (Juan Pablo) Nieto	2nd year, Telecommunication Engineer

09.30-10.00 Lecturers M Engineering and policy Analysis

Mr Prof.dr. W.M. (Martin) de Jong	Full professor, Urban and infrastructure development in China
Mr Dr. E. (Erik) Pruyt	Associate professor, System Dynamics Modelling, Exploratory Modelling and Analysis
Mr S. (Scott) Cunningham	Associate professor, Operations research, data science, tech policy
Mr Prof.dr.ir. A. (Alexander) Verbraeck	Full professor, Large-scale models, discrete event simulation, data analysis
Mr Dr.ir. L.M. (Leon) Hermans	Assistant professor, Actor models, policy analysis, water governance
Mr Dr. S.T.H. (Servaas) Storm	Assistant professor, Macroeconomics and development economics, CGE modelling

10.00-11.00 Meeting audit committee (incl. break)

11.00-12.00 Members Boards of Studies

Ms Dr.ir. M.P.M. (Tineke) Ruijgh - van der Ploeg	Chair Board of Studies TB
Mr Dr. P.W.G. (Pieter) Bots	Chair Board of Studies SEPAM

	Mr Dr. J.A. (Jan Anne) Annema	Chair Board of Studies EPA
	Mr Dr. M.P.M. (Maarten) Franssen	Chair Board of Studies MOT
	Mr M. (Mike) Band	Student member Board of Studies TB
	Mr M.E. (Martijn) Cligge	Student member Board of Studies SEPAM
	Ms R. (Rhythima) Shinde	Student member Board of Studies EPA
	Mr T. (Tim) Joosten	Student member Board of Studies MOT
11.00-11.30	Tour Faculty	
12.00-13.00	Meeting audit committee (incl. lunch)	
13.00-14.00	Members Board of Examiners	
	Mr Prof.dr. R.W. (Rolf) Künneke	Chair Board of Examiners TPM
	Mr Prof.dr. W.K. (Willem) Korthals Altes	Member Board of Examiners TPM
	Ms Drs. J. (Jolien) Ubacht	Chair Meeting of Graduation coordinators
14.00-14.30	Preparation final meeting management (incl. break)	
14.30-15.30	Final meeting management	
	Mr Prof.dr. T.S. (Theun) Baller	Dean TPM
	Mr Prof.mr.dr. E.F. (Ernst) ten Heuvelhof	Director of Education TPM
	Mr Dr.ir. I. (Ivo) Bouwmans	Director of Studies TB
	Ms Dr.ir. Z. (Zofia) Lukszo	Director of Studies SEPAM
	Mr Dr.ir. B. (Bert) Enserink	Director of Studies EPA
	Mr Dr. R.M. (Robert) Verburg	Director of Studies MOT
	Ms Drs. J.K. (Jenny) Brakels	Manager Education &Student Affairs
15.30-17.30	Meeting audit committee – first findings	
17.30-17.45	Plenary presentation first findings – ENG	
17.45	Drinks TB-café	

APPENDIX 6: THESES AND DOCUMENTS STUDIED BY THE PANEL

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

1540998	4173260	4221427
1514415	4112318	4115422
4008464	4115643	4295609
4241630	4115422	4245229
4139291	4227689	4232186

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

- Annual report Board of Examiners 2014-2015;
- Minutes of the Programme Committee;
- Course dossiers, including the tests of a selection of bachelor’s courses;