Assessment report
Limited Programme Assessment

Bachelor Electrical Engineering

Eindhoven University of Technology

Contents of the report

1. Executive summary

In this executive summary, the panel presents the main considerations which led to the assessment of the quality of the Bachelor programme Electrical Engineering of the Eindhoven University of Technology, which has been assessed according to the NVAO Assessment Framework.

The panel noted that the programme management followed up on the recommendations, made during the previous assessment in 2010. The programme management, among others, reorganized the Bachelor curriculum to raise student success rates and to strengthen the electrical engineering, mathematics and physics contents and intensified student guidance.

The programme's name, Bachelor Electrical Engineering, matches its contents and corresponds to the names of similar programmes.

The panel approves of the objectives of this programme. In the panel's view, the programme management made a distinct and clear choice to educate students to proceed and study at Master level in Electrical Engineering, thereby opening up professional and academic careers in this domain.

The panel is particularly positive about the Domain-specific Frame of Reference Electrical Engineering which the management of the Electrical Engineering programmes of the three Dutch Technical Universities drafted. To the knowledge of the panel, this Frame of Reference is the first substantial effort in the Netherlands to define and describe the Electrical Engineering domain. In the panel's opinion, this Frame of Reference presents a sound and insightful description of this domain. Dutch Electrical Engineering programmes are linked to authoritative international concepts, notions and trends in this domain.

The panel welcomes the clear choices the programme management made, to focus on four societal themes, *Connected World*, *Care and Cure*, *Smart and Sustainable Society* and *Automotive*. In addition, the panel would like to stress the importance of the Automotive programme, to the knowledge of the panel being unique as an academic programme in the Netherlands.

The programme intended learning outcomes meet the objectives. In the panel's view, these learning outcomes specify the competencies of the modern T-shaped engineer. The learning outcomes meet the requirements of the Domain-specific Frame of Reference and comply with the requirements of an academic Bachelor programme.

In the panel's view, the admission requirements are in line with legal regulations and the admission procedures, such as the matching processes, are elaborate and effective. The substantial increase in the student numbers are regarded by the panel as positive. The panel, however, advises in this respect to pay attention to the recruitment of students from abroad, to raise the number of staff positions and to maintain the students-to-staff ratio.

The intended learning outcomes are fully covered in the curriculum. Students acquire knowledge of disciplines like mathematics and physics and knowledge and skills of Electrical Engineering, both at the required level, obtain research and design skills, gain professional skills, such as communication and planning skills and are acquainted with social, ethical and business aspects. The curriculum is coherent and up-to-date.

The study method in the programme, such as lectures, instructions, tutorials, tutor groups and practical training are consistent with the contents. As the panel is very positive about the concept of *Design-based learning*, the panel advises the programme management to introduce the concept in compulsory courses as well. The panel supports the introduction of digital teaching techniques, supplementing traditional study methods.

The information provided to the students is adequate. Study advisors, coaches and student mentors ensure effective student guidance. The panel welcomes the opportunities for students, failing their first year, to seamlessly continue their studies at professional Universities.

The gradual increase in student success rates in the last few years is regarded by the panel to be positive. The panel encourages the programme management to continue along this path and achieve the Eindhoven University of Technology target figures.

As the panel observed, the lecturers are motivated to participate in the programme. They are experts in their fields, while the vast majority of them have PhD's and many of them participate in research projects in industry, contributing to an outside-in perspective. Although measures are being taken to raise the number of lecturers with BKO-certificates, the panel recommends remaining attentive in this respect. The same applies for the number of lecturers, having English certificates.

The panel is impressed by the facilities for the programme. The lecture rooms and laboratories are state-of-the-art, allowing students and lecturers to participate in up-to-date education and research.

The panel regards the test and assessment policies in the programme to be adequate, as these are directed towards ensuring transparent, valid and reliable tests and assessments. The procedures adopted by the programme management with respect to the information provision to students about tests, the drafting of tests, answering and scoring models and the assessments of tests are appropriate as well. The panel is very satisfied with the procedures for identifying and assessing individual performances of students in group projects.

The responsibilities and tasks of the Examination Committee are up to standard, as this Committee monitors the test and assessment procedures, the quality of tests and the students' achieving the intended learning outcomes of the programme.

The panel studied the tests of a number of courses and concludes these to be satisfactory in breadth and depth and to reflect the learning goals of the courses. In the panel's view, the Bachelor theses demonstrate the students having achieved the intended learning outcomes of the programme.

The assessment of the final projects is adequate, since a panel of lecturers is involved, assessing the projects by means of relevant criteria. One of the theses has been assessed as unsatisfactory by the panel. The panel considers this to be an outlier. About 25 % of the projects were regarded by the panel to be graded somewhat too high. A number of theses were clearly of good to very good quality. Some were, however, written in rather poor English and lacked a solid structure. The panel, therefore, recommends intensifying the academic English language instruction. The panel also advises to reconsider the paper-format for the Bachelor final project to allow for adequate and substantially underpinning material in the thesis, to support a clear judgement of the individual achievement and for the critical reflection on the results.

The panel assesses the Bachelor programme Electrical Engineering of the Eindhoven University of Technology to be satisfactory and recommends NVAO to grant re-accreditation to this programme.

Rotterdam, 19 December 2016

Prof. ir. A. van Ardenne
(panel chair)

W. Vercouteren MSc, RC
(panel secretary)

2. Assessment process

Certiked VBI received a request to conduct a limited programme assessment for the re-accreditation of the Bachelor programme Electrical Engineering. This request was submitted by the Eindhoven University of Technology.

Certiked requested the approval by NVAO of the proposed panel of experts to conduct this assessment. NVAO have given its approval. The panel composition was as follows (for more detailed information please refer to Annex 4: Composition of the assessment panel):

- Prof. ir. A. van Ardenne, strategic advisor-ASTRON, director Ardenne Consultancy (panel chair);
- Prof. D. De Zutter PhD, professor Electromagnetics, Ghent University (panel member);
- C.L.M. van der Klauw PhD, director of the research activities and programmes, Philips Lighting (panel member);
- E.E.M. Leo BSc, student Master programme Educational Sciences, University of Amsterdam, (student member).

On behalf of Certiked, W. Vercouteren MSc, RC was responsible for the process coordination and for drafting the panel's report. All panel members and the secretary signed a statement of independence and confidentiality.

The panel conducted this assessment on the basis of the standards of the NVAO Assessment Framework of 19 December 2014 (Staatscourant nr. 36791).

The following procedure was adopted. The panel members studied the documents presented beforehand by the programme management, including a number of theses (please refer to Annex 2 and 3: Documents reviewed and Theses reviewed). With respect to the selection and study of the theses, the panel proceeded in line with the NVAO Guidelines for the assessment of final projects during external assessments of 18 February 2015.

Before the date of the site visit, the panel chair and the panel secretary met to discuss the assessment procedures. Before the site visit date, all panel members (a) sent in their preliminary findings, based on the information file submitted by the programme management, (b) a number of questions to be put to the programme representatives on the day of the site visit and (c) their findings about the theses, they had studied. The panel secretary summarized this information.

On 28 September 2016, the panel had a meeting to discuss the preliminary findings concerning the quality of the programme. During this preliminary meeting, the findings of the panel members, including those about the theses were discussed, and a number of questions were added to the list drafted beforehand. On the basis of this input, the panel secretary drew up a final list of questions, which served as a starting point for the discussions with the programme representatives during the site visit.

On 4 October 2016, the panel conducted a site visit on the Eindhoven University of Technology campus. The site visit schedule was in accordance with the schedule drafted beforehand (please refer to Annex 1: Site visit schedule). The programme management communicated the open office hours to the students and staff of the programme. No persons presented themselves.

In a closed session at the end of the site visit, the panel considered every one of the findings, weighed the considerations and drew conclusions regarding the quality of the programme. At the end of the site visit, the panel chair presented a broad outline of the findings to the programme management.

A draft version of this report was finalised by the secretary, having taken into account the information presented as well as the findings and considerations of the panel. The draft report was sent to the panel members, who studied the draft report and made a number of changes. Thereupon, the secretary edited the final report. This report was presented to the programme management to be corrected for factual inaccuracies. After having been corrected for these inaccuracies, the report was sent to the institution's Board to accompany their request for re-accreditation of this programme.

3. Overview of the programme

3.1 Basic information about the programme

Administrative information about the programme:

Name programme in CROHO:	B Electrical Engineering
Orientation, level programme:	Academic Bachelor
Grade:	BSc
Number of credits:	180 EC
Specializations:	Electrical Engineering, Automotive
Location:	Eindhoven
Mode of study:	Full-time
Registration in CROHO:	56953

Administrative information about the institution:

Name of institution:	Eindhoven University of Technology
Status of institution:	Government-funded University
Institution's quality assurance:	Approved

Quantitative data about the programme

Percentage of students who dropped out after one, two or three years (vwo matriculation)

Cohort	2008	2009	2010	2011	2012	2013
Drop-out rate after one year	16 %	27 %	38 %	23 %	21 %	28 %
Drop-out rate after two years	20 %	27 %	42 %	28 %	23 %	30 %*
Drop-out rate after three years	26 %	27 %	44 %	32 %	27 %*	

* preliminary data

Percentage of students who continued their study in the second year and who completed the programme after three, four, five and six or more years (vwo matriculation)

Cohort	2008	2009	2010	2011	2012
Success rate after three years	14 %	11 %	13 %	17 %	14 %
Success rate after four years	36 %	51 %	34 %	42 %	
Success rate after five years	60 %	57 %	66 %		
Success rate after six or more years	76 %	74 %			

Percentage of students who continued their studies in the second year and who completed the programme after three, four, five and six or more years (all students)

Cohort	2008	2009	2010	2011	2012
Success rate after three years	11 %	8 %	14 %	15 %	14 %
Success rate after four years	27 %	37 %	31 %	37 %	
Success rate after five years	45 %	43 %	55 %		
Success rate after six or more years	58 %	55 %			

Lecturers' qualifications

Qualification	MSc	PhD	BKO*
Percentage of lecturers	100 %	97 %	60 %

*BKO means having obtained Dutch University Teaching Qualification (figure for full-time lecturers).

The student-to-staff ratio is 18.

Number of contact hours per week for each of the years of the programme

Year of the programme	Year 1	Year 2	Year 3
Number of contact hours per week	24.0	24.0	24.0/4.0*

*In regular teaching quarters the figure is 24.0 hours. During the Bachelor final project the figure is 4.0 hours.

3.2 Main facts about the institution

The Bachelor programme Electrical Engineering is a programme of the Department of Electrical Engineering of the Eindhoven University of Technology.

According to their website, the mission statement of the Eindhoven University of Technology is to be a leading, international, in engineering science and technology specialized research University. The University wants to offer excellent teaching and research and thereby contribute to the advancement of technical sciences and research in the Eindhoven region and in the world as a whole. The education, research and knowledge valorisation activities of the University are meant to contribute to the solution of major societal issues in the areas of energy, health and smart mobility, to foster the development of technological innovation in cooperation with industry and to strengthen the progress in engineering sciences through excellence in key research areas and through innovation in education.

More than 10,000 students study at the Eindhoven University of Technology, nearly 6,000 of them being Bachelor students and over 4,000 of them being Master students. There are more than 1,000 PhD-students.

The Eindhoven University of Technology comprises nine departments, being the Departments of Biomedical Engineering, Built Environment, Electrical Engineering, Industrial Design, Industrial Engineering & Innovation Sciences, Chemical Engineering & Chemistry, Applied Physics, Mechanical Engineering and Mathematics and Computer Science. These departments offer 11 Bachelor programmes and 22 Master programmes.

3.3 Intended learning outcomes

The intended learning outcomes of the programme are as follows. The graduates of the programme are expected:

- To be qualified to degree level within the domain of engineering sciences and technology.
- To understand and to be capable of interpreting the basic knowledge (theories, methods, techniques) of electrical engineering or automotive.
- To have a solid background in mathematics and an understanding of the methods of physics.
- To be competent in the relevant domain-specific discipline(s) of Electrical Engineering at the level of a Bachelor of Science, in particular:
  - The theory of electromagnetic phenomena, their generation and analysis.
  - The combination of materials with different conductivity properties and their modeling.
  - The manipulation of charge movements.
  - The acquisition of physical quantities and their transformation into useful measurements or control signals to achieve desired actuation.
  - The processing of information, being acquisition, storage, organization, transformation, retrieval, presentation and broadcasting of information as electromagnetic (including optical) signals, and the organization of components with such functions in so-called information systems.
  - The systems and techniques for signal transmission over large distances.
  - Energy conversion, where at least one form is of electrical or magnetic kind.
  - The methodology which is the basis of the design procedures for artifacts and the adequate management of their complexity with a keen eye for trade-offs between all performance characteristics.

    Additionally, Automotive Bachelors have knowledge of and understand:
  - The societal and individual interaction with mobility technology.
  - Mechanics, static as well as dynamic (vibrations).
  - Energy conversion to and from mechanical energy.
- To be able to conduct research and design under supervision.
- To be aware of the significance of other disciplines (interdisciplinary work).
- To take a scientific approach to non-complex problems and ideas, based on current knowledge.
- To possess intellectual skills that enable them to reflect critically, reason and form opinions under supervision.
- To be good at communicating the results of their learning, thinking, acts and decision-making processes.
- To be able to plan and implement their activities.
- To be aware of the temporal and societal contexts of science and technology (comprehension and analysis).
- In addition to a recognizable domain-specific profile, to possess a sufficiently broad basis to be able to work in an interdisciplinary and multidisciplinary context. Here, multidisciplinary means focusing on other relevant disciplines needed to solve the design or research problem in question.

3.4 Outline of the curriculum

In the table below, the curriculum for the Electrical Engineering track has been presented. Courses for the Automotive track have been listed between parentheses, when they differ from the Electrical Engineering track)

Curriculum components	Credits
Calculus	5 EC
Circuits (Automotive Trends I)	5 EC
Computation I (Computation for Automotive)	5 EC
Physics	5 EC
Signals I (Dynamics and Mathematics)	5 EC
Modeling	5 EC
Electronic Circuits I (Automobility)	5 EC
Mathematics I (Signals and Mathematics)	5 EC
User Society Enterprise	5 EC
Systems	5 EC
Two electives (2 x 5 EC)	10 EC
Year 1	60 EC
Design	5 EC
Electromagnetics I	5 EC
Electromechanics	5 EC
Electrical Power Systems (Fundamentals of Electronics)	5 EC
Computation II (Power Electronics)	5 EC
Introduction Telecommunication (Combustion Engine)	5 EC
Mathematics II (Sensing Computing Actuating)	5 EC
Electromagnetics II (Vehicle Dynamics and Powertrains)	5 EC
Four electives/User Society Enterprise elective courses (4 x 5 EC)	5 EC
Year 2	60 EC
Signals II (Vehicle Networking)	5 EC
Control Systems	5 EC
Communication Theory (Automotive Software Engineering)	5 EC
Electronic Circuits II (Driver-centric Innovation)	5 EC
Six electives/User Society Enterprise elective courses (6 x 5 EC)	30 EC
Bachelor final project	10 EC
Year 3	60 EC
Total credits of the programme	180 EC

4. Overview of assessments

Standard	**Assessment**
Standard 1. Intended learning outcomes	Good
Standard 2: Teaching-learning environment	Satisfactory
Standard 3: Assessment	Satisfactory
Standard 4: Achieved learning outcomes	Satisfactory
Programme	Satisfactory

5. Findings, considerations and assessments per standard

5.1 Standard 1: Intended learning outcomes

The intended learning outcomes of the programme have been concretised with regard to contents, level and orientation; they meet international requirements.

Findings
In the words of the management of this Bachelor programme, the main objectives of the Bachelor Electrical Engineering programme are to educate students to be able to enroll in Master programmes in this field and to embark upon professional careers on an academic level or careers in research in the Electrical Engineering domain. The programme objectives do not include preparing graduates directly for the labor market.

In preparation of this external assessment process, the management of the Electrical Engineering programmes of the University of Twente, the Eindhoven University of Technology and the Delft University of Technology drafted the Domain-specific Frame of Reference Electrical Engineering. In this document, the management of these programmes specify the Electrical Engineering domain, especially taking into account the international perspective. For the graduates of the Bachelor and Master programmes in Electrical Engineering consolidated requirements have been compiled. These requirements have been derived from national and international academic and professional sources, such as ABET, the United States-based Accreditation Board for Engineering and Technology and ASIIN, the German Accreditation Organization for degree programmes in Engineering, Informatics, Natural Sciences and Mathematics. In addition, the international IDEA set of qualifications for Electrical and Information Technology were taken into account.

Within the domain of Electrical Engineering, as described in the Domain-specific Frame of Reference, the programme management selected a number of focal points, these being in line with Eindhoven University of Technology policy. These focal points are *Connected World*, aimed at studying communication topics, *Care and Cure*, addressing the challenges arising out of an ageing society, *Smart and Sustainable Society*, dealing with, among others, transition to clean energy supplies and reducing power and material consumption and *Automotive*, meant to study future mobility systems.

The programme management drafted a series of intended learning outcomes (please refer to the list in section 3.3 of this report). In these learning outcomes, knowledge and skills in the field of Electrical Engineering, research and design skills, problem-solving skills, collaboration and communication skills, awareness of the social dimensions of technology and knowledge and skills of adjacent areas to be able to work in multidisciplinary or interdisciplinary settings are listed. The programme management's intention has been to describe modern T-shaped engineers and the knowledge and skills they need.

In the self-assessment report, a table was presented, from which the correspondence of the programme's intended learning outcomes to the Domain-specific Frame of Reference requirements may be derived.

In addition, the programme management has shown the intended learning outcomes to comply with the Meijers criteria, being the Dutch Technical Universities standard for the Bachelor level of the learning outcomes. From the description, presented by the programme management, it may be concluded that the intended learning outcomes of this programme meet the Meijers criteria for Bachelor programmes.

The programme management installed an Advisory Board with representatives coming from industry. As the frequency of their meetings in the last few years remained quite low, the programme management intends to organize at least one meeting per year, from now on.

Considerations
The panel approves of the objectives of this Bachelor Electrical Engineering programme of the Eindhoven University of Technology. In the panel's view, the programme management has made a distinct and clear choice to educate students to proceed and study at Master level in Electrical Engineering, thereby opening up professional and academic careers in this domain.

The panel is particularly positive about the Domain-specific Frame of Reference Electrical Engineering which the management of the Electrical Engineering programmes of the three Dutch Technical Universities drafted. To the knowledge of the panel, this Frame of Reference is the first substantial effort in the Netherlands to define and describe the Electrical Engineering domain. In the panel's opinion, this Frame of Reference presents a sound and insightful description of this domain, linking Dutch Electrical Engineering programmes to authoritative international concepts, notions and trends in this domain.

The panel is very positive about the choices the programme management made, to focus on four societal themes, being *Connected World*, *Care and Cure*, *Smart and Sustainable Society* and *Automotive*. The panel feels these clear choices add substantially to the programme's profile. In addition, the panel would like to emphasize the importance of the Automotive programme, to the knowledge of the panel being unique as an academic programme in the Netherlands.

In the panel's opinion, the intended learning outcomes of the programme meet the programme objectives. These intended learning outcomes specify not only technical knowledge and skills in the field of Electrical Engineering but also research and design skills, professional skills, such as communication and planning skills, knowledge and skills to enable students to work in multidisciplinary and interdisciplinary contexts and the awareness of the social impact of technology. In the panel's view, these intended learning outcomes specify the competencies of the modern T-shaped engineer, who not only possesses technical knowledge and skills but has knowledge of related fields, possesses academic and professional skills and is aware of the social and ethical impact of science and technology.

The panel observed the intended learning outcomes to meet the requirements of the Domain-specific Frame of Reference Electrical Engineering and, therefore, to correspond to international concepts and trends in this domain.

The panel ascertained the intended learning outcomes of the programme to comply with the Meijers criteria of the Dutch Technical Universities and, therefore, to meet the requirements of an academic Bachelor programme. The panel considers the intended learning outcomes of the programme to prepare students for Master programmes in this domain.

The panel supports the programme management's intentions regarding the position of the Advisory Board.

Assessment of this standard
These considerations have led the assessment panel to assess standard 1, *Intended learning outcomes*, to be good.

5.2 Standard 2: Teaching-learning environment

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

Findings
According to official data, the number of students enrolling in the programme substantially increased over the years from an influx of 75 students in 2010 to an influx of 183 students in 2014. These numbers even underestimate the actual growth in student numbers. About 8 % of the students is female, whereas between 15 % to 20 % of the students come from abroad. On average 30 % of the incoming students opt for the Automotive track. The vast majority of the students have as their previous education the Dutch *vwo-diploma*. The remainder of the students are from professional Universities (HBO) or come from countries outside of the Netherlands. The programme management is working hard to accommodate the large growth in student numbers by, among others, raising the number of staff positions.

The entry requirements for the students are to have a Dutch *vwo-diploma*, with the required level of physics and mathematics. Students from professional Universities having completed their first year in the field of electrical engineering and being at the required level in physics and mathematics, are admitted as well. Applicants from abroad may enter the programme, if they meet the pre-university requirements and are proficient in English. The programme is English-spoken.

The programme management informs applicants about the programme and the tracks. The drop-out rates of students in the Automotive track have been quite substantial. In the opinion of the programme management, this is the consequence of incoming students having unrealistic expectations about the contents of this track. The programme management improved the information provision to the applicants to correct their perception of this track.

The programme management organizes matching events for incoming students. In these events, the students are given a non-binding study advice upon completion of an online questionnaire and having participated in a study check interview.

The programme management presented a scheme in which the relations between the intended learning outcomes and the curriculum components have been specified. From this scheme, it may be deduced that all of the intended learning outcomes are addressed in one or more courses.

The curriculum of the programme conforms to the Eindhoven University of Technology-wide Bachelor College (please refer to section 3.4 of this report). The curriculum consists of a number of general courses (30 EC), such as Calculus, Mathematics, Physics and Modeling, a major (90 EC), covering the Electrical Engineering domain and including the Bachelor final project, a number of courses (15 EC), addressing societal, ethical and business dimensions of this domain and a number of electives (45 EC). By means of teaching-learning trajectories, the programme management intends to ensure the main aspects of the field of Electrical Engineering to be covered. This has been done for both tracks, Electrical Engineering and Automotive. The selection of electives by the students is guided by lecturers and is subject to approval by the Examination Committee. The programme management has assembled pre-approved packages of electives to help students in their selection process. These packages are consistent with the specific focal points, mentioned in standard 1. Students are taught professional skills, such as communication, collaboration and planning skills, the teaching of which has been integrated in the major courses.

Students are to take so-called User, Society, Enterprise courses (20 EC), which address societal, ethical and business aspects. Mathematics courses are offered University-wide but topics of interest for this domain are supplemented in the courses of this programme.

In the programme, a number of distinct study methods have been introduced, being lectures, instructions, tutorials, tutor groups and practical training. Some of the electives have been organized around the educational concept of *Design-based learning*, meant to stimulate students to solve ill-defined problems, applying knowledge and skills to the design of artefacts, systems and solutions. For a number of courses, digital learning techniques are being developed, such as web lectures, digital exercises and online tests.

For information on the curriculum and courses, students may access the electronic study guide. Lecturers take the role of coaches, guiding groups of about ten students and advising them on the selection of their electives. Mentors, i.e. elder students, are available for student guidance as well. Students may consult study advisors, who monitor the student's study pace and assist students. In the first year, students are to achieve more than 45 EC. Otherwise, they will be forced to leave the programme, this being the consequence of the binding advice on the continuation of studies (in Dutch: BSA). The study advisor warns students in the case of the threat of a negative BSA. Students in the Electrical Engineering track failing to succeed during their first year, may continue their studies at the Fontys University of Applied Sciences (HBO) without delay. Students in the Automotive track who fail to complete their first year may proceed to the Fontys University of Applied Sciences or to the HAN University of Applied Sciences (both HBO-institutions). The arrangements for the latter students have not yet been formalized, as has been done for the Electrical Engineering track students.

The student success rates improved over the last few years. The percentage of students re-enrolling in the second year and then completing the programme within three years, increased from 11 % (cohort 2008) to 14 % (cohort 2012), whereas the number of these students completing the programme within four years went up from 27 % (cohort 2008) to 37 % (cohort 2011). These rates include both tracks. These success rates do not yet meet the Eindhoven University of Technology target figures. Although the figures have improved, the programme management intends to continue to take measures to further raise the student success rates.

The number of staff in the Department of Electrical Engineering amounts to 120 lecturers (83 FTE) and a substantial number of temporary staff. About 97 % of the lecturers in the programme obtained PhD's and are active researchers in their fields of expertise. Many staff members are involved in research and engineering projects in industry. About 60 % of the full-time lecturers obtained the Dutch University Teaching Qualification (BKO). Measures have been taken to raise this figure, in particular lecturers not being promoted, if they do not have BKO-certificates. Over 44 % of the staff members have an English certificate, proving their proficiency in the English language. Dutch National Student Survey results show the students in this programme to be satisfied with the lecturers' performances.

Lecture and project rooms are available. Students have access to laboratories at the Eindhoven University of Technology campus for laboratory work and work on the Bachelor final project. The panel was offered the opportunity to visit a number of these brand new facilities.

Considerations
The panel regards the admission requirements to be in line with legal regulations and the admission procedures, among which the matching processes of the programme, to be elaborate and effective. In the panel's view, applicants are well-informed by the programme management. The panel is positive about the increase in student numbers over the last years, but, however, advises in this respect to pay attention to the recruitment of students from abroad, to increase the number of staff positions and to maintain the students-to-staff ratio.

The curriculum covers the intended learning outcomes of the programme adequately. The panel is positive about the contents, as students acquire knowledge of disciplines, such as mathematics and physics and of Electrical Engineering, both at the required level, obtain research and design skills and gain professional skills, such as communication, collaboration and planning skills. In addition, students are amply acquainted with social, ethical and business aspects of this field. The curriculum is regarded by the panel to be consistent with, if not leading in the modern T-shaped engineer requirements. The learning-teaching trajectories, the guidance in assembling electives and pre-defined elective packages ensure coherence in the curriculum. The panel regards the curriculum to be up-to-date.

The study methods, such as lectures, instructions, tutorials and practicals are consistent with the contents of the programme and, in the panel's view, allow students to organize their learning processes effectively. As the panel is very positive about the concept of *Design-based learning*, the panel advises the programme management to introduce the concept not only in electives but also in compulsory courses. The panel supports the introduction of digital teaching techniques, supplementing traditional study methods.

The information provided to the students and the study guidance are appropriate. The student-to-staff ratio of 18 (please refer to section 3.1 of this report) is quite favorable. It may be a challenge to maintain this ratio, given the rise in student numbers. The study advisors, coaches and student mentors ensure effective guidance of students. The BSA-requirement is monitored adequately by the student advisors. The panel welcomes the opportunities for students, failing their first year, to continue their studies at professional Universities.

The panel is positive about the gradual increase in student success rates in the last few years, encouraging the programme management to continue and achieve the Eindhoven University of Technology target figures.

The panel regards the lecturers to be motivated to participate in this programme and to be experts in their fields. The vast majority of them have a PhD and many of them participate in research projects in industry. Although strong measures are being taken to raise the number of lecturers with BKO-certificates, the panel recommends remaining attentive in this respect. The same applies for the number of lecturers in possession of certificates of proficiency in English.

The panel is impressed by the facilities for the programme. Having visited lecture rooms and laboratories, the panel considers these to be state-of-the-art, allowing students and lecturers to participate in up-to-date education and research.

Assessment of this standard
These considerations have led the assessment panel to assess standard 2, *Teaching-learning environment*, to be satisfactory.

5.3 Standard 3: Assessment

The programme has an adequate assessment system in place.

Findings
The Department of Electrical Engineering designed an assessment policy. This policy is in line with the assessment policy of the Eindhoven University of Technology. The main goals of the Department policy is to ensure transparent, valid and reliable tests and assessments and to provide guidelines for the Examination Committee.

For each of the tests, students are informed timely about the nature and conditions of the test. The programme management is in the process of drafting test matrices to align the courses' learning goals and tests' contents. Answering models for written examinations or scoring models or rubrics to assess assignments are drafted prior to the tests. The assessment of tests is done by at least two lecturers, using the answering or scoring models. In case of group projects, student feedback within the group of students or the assessment of the individual contribution of every one of the students in the group is adopted to counter free-riding.

An Examination Committee has been installed for the programmes of the Department of Electrical Engineering. The Examination Committee acts in conformity with Dutch law, monitoring the examination rules and regulations, ensuring the quality of the tests and verifying that the graduates of the programme have achieved the intended learning outcomes. Since the number of students increased substantially, sub-committees have been given a mandate to perform some of the Examination Committee's duties, such as approving study programmes and granting exemptions.

The programme management specified for each of the courses the test methods. For nearly all courses in the programme, a variety of distinct tests methods have been specified. Test methods adopted are dependent upon the learning goals of the courses and include written examinations, oral presentations, project assignments, quizzes or homework. At least 30 % of the final grade of each of the courses is obtained through interim tests. Interim tests are also used as feedback instruments to inform students about their study progress. In addition, diagnostic tests are used in the courses.

The Bachelor final projects are individual 10 EC projects at the end of the curriculum, to which may be added another 5 EC. The projects are planned quite rigorously and students are required to complete the project within the time set. The projects are assessed by a permanent panel of lecturers. The project supervisor will only act as an advisor. The panel assesses the student's performance by means of an assessment form with criteria, these criteria being specialized knowledge, research and design skills, professional skills, such as planning skills, organizational skills and oral and written communication skills.

Considerations
In the panel's opinion, the test and assessment policies in the programme are adequate, as these comply with the Eindhoven University of Technology assessment policy and are directed towards ensuring transparent, valid and reliable tests and assessments.

The panel regards the procedures adopted by the programme management with respect to the tests and assessments to be satisfactory with regard to the information provision to students about the tests, the drafting of the tests, answering models and scoring models and the test assessments. The panel is satisfied with the procedures for identifying and assessing individual performances of students in group projects.

The panel is positive about the position, responsibilities and tasks of the Examination Committee, monitoring the test and assessment procedures, the quality of the tests and the students' achieving the intended learning outcomes of the programme.

The assessment of the Bachelor final projects is regarded by the panel to be adequate, since a panel of examiners is involved, assessing the projects in an organized way and by means of a set of relevant criteria.

Assessment of this standard
The considerations have led the assessment panel to assess standard 3, *Assessment*, to be satisfactory.

5.4 Standard 4: Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.

Findings
The panel members studied a total of 15 Bachelor theses and discussed these within the panel. The Bachelor final projects' subjects are related to one of the focal points, mentioned under standard 1, *Connected World, Care and Cure, Smart and Sustainable Society* and *Automotive*. Students are expected to demonstrate being able to address ill-defined problems and to achieve realistic designs in the Electrical Engineering field, applying theory, defining models and showing their research and design skills and their professional skills, such as communication skills.

The programme management listed the grades for the Bachelor final projects for the last three years in order to illustrate the level achieved by the students. The average grade for these projects was between 7.5 and 8.0 for these last three years. About 5 % of the students graduate from the programme with distinction.

Considerations
Having studied the tests of a number of courses which the programme management presented, the panel concluded these tests to be satisfactory in breadth and depth and to reflect the learning goals of the courses.

One of the Bachelor theses, the panel studied, has been assessed as unsatisfactory by the panel. The panel considers this to be an outlier, not representative of the general quality of the final projects. Although the performances of the students and the grades given differ, some general observations about the projects' quality may be made. About 25 % of the theses were regarded by the panel to be graded somewhat too high. A number of the theses were clearly of good to very good quality. Some were, however, written in rather poor English and lacked a solid structure. The panel, therefore, recommends intensifying the academic English language instruction in the programme.

Although the panel respects the programme management's choices regarding the format for the final projects, the panel advises to reconsider the paper-format to allow for adequate substantial material in the thesis, to support a clear judgement of the individual achievement and for the critical reflection on the results.

In the panel's view, the Bachelor theses demonstrate the students having achieved the intended learning outcomes of the programme.

Assessment of this standard
The considerations have led the assessment panel to assess standard 4, *Achieved learning outcomes*, to be satisfactory.

6. Recommendations

In this report, a number of recommendations have been listed. For the sake of clarity, these have been brought together below. The recommendations are the following.

- Given the considerable growth in student numbers, to pay attention to the recruitment of students from abroad, to increase the number of staff positions and to maintain the students-to-staff ratio.
- To introduce the concept of *Design-based learning* not only in electives but also in compulsory courses, as this concept may be instrumental in promoting the students' learning processes.
- To remain attentive with regard to the number of lecturers, being in possession of BKO-certificates or certificates of proficiency in English.
- To intensify the English academic writing skills instruction in the programme, because in some Bachelor theses the quality of the English was rather poor and the structure could have been improved.
- To reconsider the paper-format of the Bachelor final project to allow for adequate substantial material in the thesis, to support a clear judgement of the individual achievement and for the critical reflection on the results

Annex 1: Site visit schedule

The site visit was at Eindhoven University of Technology campus on 4 October 2016. The schedule was as follows.

08.30 h. – 09.00 h.	Arrival and deliberations panel (closed session)
09.00 h. – 09.30 h.	Dean and programme management Prof. ir. B. Smolders PhD (Dean Department of Electrical Engineering), ir. H. de Waardt PhD (director Master programme Electrical Engineering), ir. S. Hulshof (director Bachelor programme Electrical Engineering), J. van Wevelingen MSc (business managing director), D. Daverveld (student advisor Department Board)
09.30 h. – 11.00 h.	Programme management and core lecturers Prof. ir. B. Smolders PhD (Dean Department of Electrical Engineering), ir. H. de Waardt PhD (director Master programme Electrical Engineering), ir. S. Hulshof (director Bachelor programme Electrical Engineering), ir. M. van Beurden PhD (lecturer), ir. H. Jansen PhD (lecturer), prof. S. Weiland PhD (chair Educational Committee), S. Gomez Puente PhD (education advisor)
11.15 h. – 12.00 h.	Examination Committee Prof. ir. T. Basten PhD (chair), E. Bente PhD (member), ir. J. Vleeshouwers PhD (advisor), prof. ir. L. Feijs PhD (external member), prof. S. Weiland PhD (chair Educational Committee), ir. T. Tjalkens PhD (member), S. Gomez Puente PhD (education advisor)
12.00 h. – 13.00 h.	Lunch panel (closed session), open office hours 12.00 h. – 12.30 h.
13.00 h. – 13.45 h.	Meeting with Eindhoven University of Technology Rector Magnificus prof. ir. F. Baaijens PhD and Dean and tour around facilities (various laboratories)
13.45 h. – 14.45 h.	Lecturers of a various courses and theses' examiners S. Zinger PhD, ir. S. Stuijk PhD, M. Matters PhD, M. Lazar PhD, ir. A Tijsseling PhD, ir. R. Mestrom PhD, prof. ir. P. Baltus PhD, S. Gomez Puente PhD (education advisor)
14.45 h. – 15.30 h.	Students and alumni, including Educational Committee members L. Zhang (Bachelor student), T. van Teeffelen (Bachelor student), J. Borsboom (Bachelor student Automotive), S. Beumer BSc (Master student), R. Sanders BSc (Master student), J. Scholten MSc (alumnus), L. Chan MSc (alumna), E. Raaijmakers MSc (alumna)
15.30 h. – 16.00 h.	Representatives from industry C. van Dinther (NXP), P. van Zeijl (Omniradar), G. van den Hoven (Genexis)
16.00 h. – 16.15 h.	Programme management Prof. ir. B. Smolders PhD (Dean), S. Gomez Puente PhD (education advisor)
16.15 h. – 17.30 h.	Deliberations panel (closed session)
17.30 h. – 17.45 h.	Main findings presented by panel chair to the programme management

Annex 2: Documents reviewed

The panel studied the following documents, presented prior to the site visit:

- Self-assessment report Bachelor Electrical Engineering
- Relation between intended learning outcomes and courses
- Relation between teaching-learning trajectories and courses
- General Eindhoven University of Technology framework: Engineers for the Future
- Curriculum overviews Electrical Engineering and Automotive
- Overview of composition of teaching staff
- Overview of teaching staff
- Student-to-staff ratio
- Forms of education and assessment
- List of recent graduates
- Elective packages
- Course details Bachelor Electrical Engineering and Automotive
- Key quantitative data
- Domain-specific Frame of Reference
- Assessment policy of Department of Electrical Engineering
- Meijers criteria
- Final report task force redesign Bachelor curriculum (in Dutch)
- Programme and examination regulations
- Analysis and investment plan growth student numbers Electrical Engineering (in Dutch)
- Overall evaluation impact Bachelor College reform and next steps
- Regulations Examination Committee
- Research report Department of Electrical Engineering

On the day of the site visit, the programme management presented the following documents:

- Literature
- Course material (representative selection)
- Tests and examinations (representative selection)
- Examination Committee annual reports
- Educational Committee annual reports and minutes

Annex 3: Theses reviewed

The Bachelor final projects (theses) of the following 15 students have been selected for review by the panel

- 0824530
- 0811238
- 0774928
- 0813501
- 0743882
- 0773914
- 0814860
- 0821521
- 0768002
- 0738698
- 0809921
- 0740026
- 0781483
- 0807014
- 0716178

Annex 4: Composition of the assessment panel

The assessment panel had the following composition:

- Prof. ir. A. van Ardenne, strategic advisor-ASTRON, director Ardenne Consultancy (panel chair);
- Prof. D. De Zutter PhD, professor Electromagnetics, Ghent University (panel member);
- C.L.M. van der Klauw PhD, director of the research activities and programmes, Philips Lighting (panel member);
- E.E.M. Leo BSc, student Master programme Educational Sciences, University of Amsterdam, (student member).

Prof. ir. A. van Ardenne, panel chair
Mr. Van Ardenne graduated from Twente University of Technology as a Master of Science in Electronics and Applied Physics. Having completed his studies, he held, among others, positions as a research engineer, scientific project manager, research & development director and technical director at organizations like ASTRON/NWO, Ericsson Radio Systems and NOFIQ Firesystems. From 2006 to 2015, he was adjunct professor Radio Astronomy at Chalmers University of Technology, Gothenburg, Sweden. Mr. Van Ardenne, currently, is working as a strategic advisor to, among others, the Dutch province of Drenthe, in particular advising on research programmes and space-related activities.

Prof. D. De Zutter PhD, panel member
Mr. De Zutter received his Master of Science degree in Electrical Engineering from Ghent University. He was a research assistant at this University, subsequently obtained a PhD and completing a thesis, leading to the degree equivalent of the French Aggrégation. He, currently, is a full professor of Electromagnetics at Ghent University. His main research interests are circuit and electromagnetic modeling of high-frequency interconnections and packaging, electromagnetic compatibility (EMC) and numerical solutions of Maxwell's equations. Mr. De Zutter is a Fellow of the IEEE. Previously, he held the position of Dean of the Faculty of Engineering of Ghent University.

C.L.M. van der Klauw PhD, panel member
Mr. Van der Klauw graduated as a Master of Science in Electronics Engineering from Delft University of Technology and received a PhD in the area of semiconductor devices (CCD's). Having completed his studies, he joined Philips Research, working on the design and characterization of CMOS devices and processes. Subsequently, he was employed at Philips Flat Panel Displays, being involved in establishing Philips' joint ventures in Korea and Japan. Subsequently, he worked as Chief Technology Officer in Philips Television. Mr. Van der Klauw is, currently, in charge of the research programme of Philips Lighting.

E.E.M. Leo, student member
Ms. Leo is a student in the Master programme Educational Sciences of University of Amsterdam. Previously, she completed the Bachelor programme in Educational Sciences at this University. She was, among others, a member of the Educational Committee of her programme and vice-chair of the Student Council of the Faculty of Social and Behavioral Sciences of University of Amsterdam. Ms. Leo participates as a student member on a regular basis in NVAO-accreditation panels.