ADVANCED TECHNOLOGY

FACULTY OF SCIENCE AND TECHNOLOGY

UNIVERSITY OF TWENTE

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CONTENTS

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REPORT ON THE BACHELOR'S PROGRAMME ADVANCED TECHNOLOGY OF UNIVERSITY OF TWENTE

This report takes the NVAO's Assessment Framework for the Higher Education Accreditation System of the Netherlands for limited programme assessments as a starting point (September 2018).

ADMINISTRATIVE DATA REGARDING THE PROGRAMME

Bachelor's programme Advanced Technology

Name of the programme:	Advanced Technology
CROHO number:	50002
Level of the programme:	bachelor's
Orientation of the programme:	academic
Number of credits:	180 EC
Location(s):	Enschede
Mode(s) of study:	full time
Minor in education:	applicable (second degree qualification)
Language of instruction:	English
Submission deadline NVAO:	01/05/2020

The visit of the assessment panel Advanced Technology to the Faculty of Science and Technology of University of Twente took place on 3 December 2019.

ADMINISTRATIVE DATA REGARDING THE INSTITUTION

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

COMPOSITION OF THE ASSESSMENT PANEL

The NVAO has approved the composition of the panel on 19 September 2019. The panel that assessed the bachelor's programme Advanced Technology consisted of:

- Dr. C. (Cees) Terlouw [chair], senior researcher at Terlouw Consultancy & Advies and Emeritus Associate Professor (lector) of Saxion University of Applied Sciences;
- Prof. Dr.-Ing. G. (Gerhard) Schmitz, professor Engineering Thermodynamics at Hamburg University of Technology (Germany);
- Prof. Dr. M. (Michael) Wick, professor Sensor Technology at Coburg University of Applied Sciences and Art (Germany);
- Dr. S. (Stephan) Ramaekers, programme coordinator physiotherapy and Associate Professor at the Amsterdam University of Applied Sciences;
- P. (Philippa) Vossen, BSc. [student member], master student Aerospace Engineering at the Delft University of Technology.

The panel was supported by P.A. (Peter) Hildering MSc, who acted as secretary.

WORKING METHOD OF THE ASSESSMENT PANEL

On behalf of the participating universities, quality assurance agency QANU was responsible for logistical support, panel guidance and the production of the report. P.A. (Peter) Hildering MSc was project coordinator for QANU. He also acted as secretary in the assessment.

Preparation
On 3 October 2019, the panel chair was briefed by QANU on his role, the assessment framework, the working method, and the planning of site visit and report. A preparatory panel meeting was organised on 2 December 2019. During this meeting, the panel members received instruction on the use of the assessment framework. The panel also discussed their working method and the planning of the site visit and report.

The project coordinator composed a schedule for the site visit in consultation with the programme. Prior to the site visit, the programme selected representative partners for the various interviews. See Appendix 4 for the final schedule.

Before the site visit to University of Twente, QANU received the self-evaluation report of the programme and sent this to the panel. A thesis selection was made by the panel's chair and the project coordinator. The selection existed of 15 theses and their assessment forms for the programmes, based on a provided list of graduates between 2017 and 2019. A variety of topics and tracks and a diversity of examiners were included in the selection. The project coordinator and panel chair assured that the distribution of grades in the selection matched the distribution of grades of all available theses.

After studying the self-evaluation report, theses and assessment forms, the panel members formulated their preliminary findings. The secretary collected all initial questions and remarks and distributed these amongst all panel members.

At the start of the site visit, the panel discussed its initial findings on the self-evaluation report and the theses, as well as the division of tasks during the site visit.

Site visit
The site visit to University of Twente took place on 3 December 2019. Before and during the site visit, the panel studied the additional documents provided by the programme. An overview of these materials can be found in Appendix 5. The panel conducted interviews with representatives of the programme: students and staff members, the programme's management, faculty board, alumni and representatives of the Board of Examiners. It also offered students and staff members an opportunity for confidential discussion during a consultation hour. No requests for private consultation were received.

The panel used the final part of the site visit to discuss its findings in an internal meeting. Afterwards, the panel chair publicly presented the panel's preliminary findings and general observations.

Report
After the site visit, the secretary wrote a draft report based on the panel's findings and submitted it to the project coordinator for peer assessment. Subsequently, the secretary sent the report to the panel. After processing the panel members' feedback, the project coordinator sent the draft report to the Programme Board and Faculty Board in order to have it checked for factual irregularities. The project coordinator discussed the ensuing comments with the panel's chair and changes were implemented accordingly. The report was then finalised and sent to the Faculty and University Board.

Minor in Education
The Minor in Education leading to a second degree teaching qualification will be covered in-depth in the assessment of the academic teaching programmes in 2020.

Definition of judgements standards
In accordance with the NVAO's Assessment framework for limited programme assessments, the panel used the following definitions for the assessment of the standards:

Generic quality
The quality that, from an international perspective, may reasonably be expected from a higher education Associate Degree, Bachelor's or Master's programme.

Meets the standard
The programme meets the generic quality standard.

Partially meets the standard
The programme meets the generic quality standard to a significant extent, but improvements are required in order to fully meet the standard.

Does not meet the standard
The programme does not meet the generic quality standard.

The panel used the following definitions for the assessment of the programme as a whole:

Positive
The programme meets all the standards.

Conditionally positive
The programme meets standard 1 and partially meets a maximum of two standards, with the imposition of conditions being recommended by the panel.

Negative
In the following situations:
- The programme fails to meet one or more standards;
- The programme partially meets standard 1;
- The programme partially meets one or two standards, without the imposition of conditions being recommended by the panel;
- The programme partially meets three or more standards.

SUMMARY JUDGEMENT

The bachelor's programme Advanced Technology is a unique, broad and multidisciplinary engineering programme aimed at educating students to acquire broad, intercultural, problem-solving skills as well as in-depth knowledge of a specific domain of choice. The panel praises the programme for its efforts to balance width and depth, and encourages it to persist in this endeavour. The programme's goals have been well translated into a coherent set of ILOs that are geared with the requirements and expectations of the academic and professional field through the 4TU ACQA Framework and a reference framework consisting of other national and international science and engineering programmes. The PILOs are tied in with an academic bachelor's programme in terms of level and orientation. The programme might consider adding more entrepreneurial skills to them.

The programme’s ILOs have been well translated into a coherent curriculum, structured alongside the principles of the university-wide Twente Education Model (TEM). The panel concludes that TEM fits the multidisciplinary goals of the programme very well by combining fundamental knowledge in science and engineering with skills and integrative projects. Students are able to shape the programme to their own goals and preferences by gradually specializing in a specific discipline in order to prepare for a subsequent master's programme. The modules are designed in module teams consisting of qualified lecturers from several faculties. Course and module goals are explicitly linked to the ILOs, and care is taken to distribute the workload evenly throughout the 10-week module. The students appreciate the good atmosphere within the programme and the accessibility and approachability of their teachers. The panel praises the programme for successfully organizing a coherent multidisciplinary curriculum.

The panel considers the choice for an English language programme well supported in relation to the programme's goals with regard to intercultural skills, and the teaching staff is sufficiently skilled to provide education in English. To be able to continue to realize its intercultural goals, the programme should continue the careful monitoring of its international intake, and take measures to increase this if necessary. With regard to the design of the programme, the panel recommends to make the students’ programming skills development more explicit by bringing them into a separate learning trajectory, strengthening the attention paid to academic writing (as already planned by the management), and increasing the visibility of individual learning trajectories, for instance through student portfolios. The programme-specific facilities adequately support students during their projects and practicals. The programme is feasible: the workload is reported by students as high but doable. The panel encourages the programme to keep up the attention paid to possible mismatches of prospective students with the programme given the high dropout rate, and to consider the introduction of mentoring to further support students in managing their workload.

The programme has a valid, transparent and reliable system of assessment in place. The assessment methods are varied and show a good balance between individual and group assignments. The module assessment plans provide a clear overview of the module goals and the intended learning outcomes. They could be further improved by explicitly describing how the individual tests relate to the module learning goals. Assessment of the bachelor's thesis has a solid design with a three-person assessment committee. The assessment form in use is adequate, but could profit from more detailed categories related to the intended learning outcomes, a stricter use of the rubric, and standardization of its use. The Examination Board of the programme fulfils its formal tasks, and monitors the realization of intended learning outcomes by individual students. With these fundamental aspects covered, its role could be enlarged from an advisory one into a more proactive one in designing the assessment system.

The panel concluded that the bachelor assignments of the programme Advanced Technology are of good quality and convincingly show that the intended learning outcomes of the programme are achieved by the students. Graduates are prepared to enter multi- and monodisciplinary master's programmes in a wide range of fields, and look back positively on the programme.

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

Bachelor's programme Advanced Technology

Standard 1: Intended learning outcomes	meets the standard
Standard 2: Teaching-learning environment	meets the standard
Standard 3: Student assessment	meets the standard
Standard 4: Achieved learning outcomes	meets the standard
General conclusion	positive

The chair, Dr. Cees Terlouw, and the secretary, Peter Hildering, of the panel hereby declare that all panel members have studied this report and that they agree with the judgements laid down in the report. They confirm that the assessment has been conducted in accordance with the demands relating to independence.

Date: 16 March 2020

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

Standard 1: Intended learning outcomes
The intended learning outcomes tie in with the level and orientation of the programme; they are geared to the expectations of the professional field, the discipline, and international requirements.

Findings

Mission and vision
The bachelor's programme Advanced Technology is a broad, multidisciplinary programme offered by the Faculty of Science and Technology of the University of Twente. Its design was based on the notion that new applications in science and engineering are often the result of interaction between multiple disciplines. For instance, developing mechanical robots requires knowledge of electromechanical systems & control, aerodynamics, biology, societal impact and entrepreneurship. The programme aims to educate T-shaped professionals with a broad range of problem-solving skills, who also know a specific domain in depth. There are several specific domains to choose from. Over the course of the programme, students are exposed to a wide range of science and engineering fields in all faculties of the university, and are supported in developing themselves further in preparation for a master's programme of their choice. The interaction with different disciplines is aimed at providing students with a helicopter view, allowing them to analyse a problem from different perspectives.

In line with the educational philosophy of the University of Twente, students are educated in different roles: research, design and organization (the 3 O’s: 'onderzoeken', ' ontwerpen' and 'organiseren'). The programme also embraces the entrepreneurial character of the university (sometimes called the fourth O: 'ondernemen') by introducing students to innovation, entrepreneurship and trend analysis. Intercultural skills also play an important role in the programme. It targets an international community of students, and aims to bring them together in an international classroom in which they are able to collaborate in a multidisciplinary, intercultural team.

The panel considers the programme’s mission and vision as positive. It recognizes the unique multidisciplinary and international profile: the bachelor's programme Advanced Technology is a unique, broad and multidisciplinary engineering programme aimed at educating students to acquire broad, intercultural, problem-solving skills as well as in-depth knowledge of a specific domain of choice. Based on the interviews held during the site visit, it further concludes that the T-shaped professional is a well-developed concept within the programme. In its opinion, the profile aligns with the requirements for modern engineers in the professional field, who should be able to bridge multiple disciplines as well as contribute to a specific discipline and cooperate in an intercultural team. The T-shape requires a careful balance between a broad multidisciplinary approach and room for monodisciplinary specialization. This balance needs continuous monitoring in order to meet the multidisciplinary goals of the programme while simultaneously qualifying students for a wide range of master's programmes. The programme management recognizes this and tries to manage this balance throughout the curriculum. The panel praises the programme for its efforts and encourages it to keep up the monitoring the balance between width and depth in the programme.

Intended learning outcomes
The programme has translated its goals into the set of six Programme Intended Learning Outcomes (PILOs) as presented in Appendix 1. They are based on the Academic Competences and Quality Assurance (ACQA) framework for bachelor's programmes. The ACQA framework (also known as the Meijers criteria) has been developed by the Dutch technical universities (4TU) as a translation of the Dublin descriptors for higher education in engineering. To align its PILOs with the international requirements of the field, the programme has composed a domain-specific framework of reference

based on an analysis of a number of monodisciplinary and broad science and engineering programmes. It has formulated a programme core of content and skills that it considers to be fundamental to science and engineering programmes, and included this in the ILOs.

The panel studied the ILOs of the bachelor's programme Advanced Technology and concluded that they form a convincing and well-structured overview of the main goals of the programme translated into the knowledge and skills to be acquired by the students. The use of the Meijers criteria in designing the ILOs guarantees that they meet the bachelor's level and academic orientation, as well as cover the general engineering skills required by the academic and professional field. The panel was impressed by the thorough comparison with other science and engineering programmes in the domain-specific framework of reference, leading to a well-substantiated programme core. Compared with the programme's mission and vision, the panel noted a lack of attention paid to entrepreneurial skills in the ILOs. It suggests adding them if the programme considers this to be a core aspect.

Considerations
The bachelor's programme Advanced Technology is a unique, broad and multidisciplinary engineering programme aimed at educating students to acquire broad, intercultural, problem-solving skills as well as in-depth knowledge of a specific domain of choice. The panel praises the programme for its efforts to balance width and depth, and encourages it to persist in this endeavour. The programme's goals have been well translated into a coherent set of ILOs that are geared with the requirements and expectations of the academic and professional field through the 4TU ACQA Framework and a reference framework consisting of other national and international science and engineering programmes. The PILOs are tied in with an academic bachelor's programme in terms of level and orientation. The programme might consider adding more entrepreneurial skills to them.

Conclusion
Bachelor's programme Advanced Technology: the panel assesses Standard 1 as 'meets the standard '.

Standard 2: Teaching-learning environment
The curriculum, the teaching-learning environment and the quality of the teaching staff enable the incoming students to achieve the intended learning outcomes.

Findings

Curriculum, coherence and teaching methods
The curriculum of the bachelor's programme Advanced Technology is structured using the principles of the Twente Educational Model (TEM). This model is characterized by the integration of courses in thematic 10-week modules of 15 EC each. The modules are designed to focus on overarching themes such as Mechanics, Thermodynamics, Fundamentals of Materials, and Business & Society. Within each theme, multiple theoretical, mathematical and lab courses are integrated into a coherent unit, alongside a capstone project. This group project presents students with a specific challenge that requires the skills and knowledge taught in the courses, supplemented by the knowledge and skills they have gained independently. With TEM, the university aims to teach students to study themes in an integrative manner, and discover the roles of researcher, designer and organizer by practising them in project groups. Especially in the first year, the students are extensively guided by tutors in their project work, and reflect on their team roles. In the first half of the year, the teams are composed by the programme, with explicit attention paid to forming multicultural groups to give students the opportunity to practise intercultural skills.

The modules of the first year mainly focus on the fundamentals of science and engineering with the themes of Mechanics, Thermodynamics, Fundamentals of Materials and Dynamics. Students are trained in experimental skills and research and design methodology. The second year expands on these basics with the Signals, Models & Systems and Fields & Waves modules, and adds a module on Business & Society that covers product development and the societal impact of innovations. In the elective module in the second year, students make their first choice about which direction they want to specialize in. There are four directions to choose from: mechatronics and control, process engineering, materials science or computer science. This is meant to be an introduction to the specialization options: if this does not match their expectations, the students can still switch in the third year of the programme. The third year is fully devoted to one specialization (45 EC) and the bachelor thesis (15 EC, including preparation). Students specialize by choosing modules or courses to prepare for admission to a master's programme of their choice. This can be a master's programme inside or outside the University of Twente. Additionally, students can opt for a university-wide 30 EC educational minor, leading to a second-degree teaching qualification. As a result, each student follows an individual programme that he or she composes in consultation with the study advisor, and which requires approval from the Board of Examiners. For 18 master's programmes at the University of Twente, ready-made pathways are available. The bachelor's thesis is an individual research or design project conducted in one of the university's research groups on either a multidisciplinary topic or a monodisciplinary topic in the field in which the student is specializing. Students can choose to follow an optional 4 EC preparation course for the bachelor’s thesis, which covers academic writing and research methodology.

The design of the curriculum in relation to the (P)ILOs is based on constructive alignment. The programme has documented how each module contributes to the attainment of the learning outcomes, and which teaching methods are used in doing this. This overview is updated annually by the programme management and the teaching staff when composing the assessment plan.

The panel studied the structure and content of the curriculum as well as the content of a selection of modules within the programme, and spoke to the programme management, teaching staff and students. It concluded that the programme’s ILOs are well and coherently incorporated into the curriculum. The assessment plan provides an insightful overview of all ILOs within the programme, and the modules in which they are covered. The panel considers the TEM approach and the associated teaching methods a strong point of the programme that aligns very well with its multidisciplinary goals. The modules offer fundamental knowledge of science and engineering from various disciplines in an integrated way, including academic and general skills and competences. This is especially visible in the projects, which the panel considers excellent integrating opportunities that require students to work in a multidisciplinary, intercultural and independent way on a challenging and realistic problem. The panel thinks that the skills acquired through these projects align very well with the modern skills required by the professional field, such as collaboration, communication and creativity. The educational minor is a welcome addition for students who want to explore the possibilities for a career in teaching. The panel considers the bachelor’s project to be a fitting capstone to the programme, giving students the opportunity to demonstrate their knowledge and skill as a T-shaped engineer in either width of depth (or both).

During the site visit, the panel discussed with the programme representatives the extent to which the individual attainment of skills is monitored within the curriculum. As most skills and competences are associated with group projects, the amount of training in a specific skill can vary depending on the division of tasks within the project groups. The programme management, teaching staff and students explained that the task division in project groups is the responsibility of students. Over the course of the modules, there are several individual tests on skills and competences, such as writing, presenting and literature research, and it is up to the student to find opportunities to practise them in the projects. In the first year, the students are closely tutored to help them manage this group work. The panel is convinced that there are enough opportunities for practising skills, and that each student is adequately assessed individually, but suggests that the programme might investigate whether the individual learning trajectories of students, as formulated in the self-evaluation report in terms of expectations (appendix D) can be made more visible. This could take the form of an individual portfolio, for instance, which details what team role and skills were emphasized in the different modules, or individual feedback for students with regard to which skills need to be further developed.

Furthermore, the panel noted that programming skills are not mentioned in the assessment plan as a separate skill, but rather implemented on a meta-level within the curriculum, and with that implicitly present in the relevant modules. Due to the importance of programming in a science and engineering programme, it recommends making programming skills more explicit into a separate learning trajectory in order to clarify where they are addressed within the programme. Finally, the panel noted from the theses studied that some students struggle with academic writing skills, for instance in terms of structuring and formatting. It understood during the site visit that this had been recognized by the programme, and that the programme management is planning to strengthen the attention to academic (English) writing in the curriculum. This plans includes making the optional bachelor's thesis preparation course mandatory for all students. The panel encourages the programme to implement these planned changes.

Language and internationalization

The bachelor's programme has been offered in English since 2010. This switch was made in line with the vision to offer the programme to an international community. This allows students to develop intercultural competences, which are essential for collaboration in multidisciplinary teams in the international environment of advanced technology. The teaching staff of the programme is also increasingly international, which further improves the international context of the programme. All newly appointed staff have to meet the required level of English proficiency (C1) set by university policy. The programme employs the educational approach of the international classroom by mixing Dutch and international students in such a way that they have to work together and learn from each other. Collaboration and English language skills are explicit goals for the students, on which they are assessed throughout the programme. Students are offered opportunities to improve their English proficiency through courses and workshops from the university's language centre.

The panel deems the choice for an English language programme as well supported and relevant with regard to the international academic and professional context in which many of the programme's graduates can be expected to work in their future careers. The teaching staff is international and selected for their English proficiency, and students are well supported in developing their English language skills. The programme cultivates the idea of the international classroom and uses this context to offer its students an intercultural experience.

However, the panel noted that the percentage of international students enrolling in the programme is currently dropping, from 35% in 2012 to 20% in 2018. As the acquisition of intercultural skills in an international classroom is part of the programme's ILOs, it recommends that the programme continues the careful monitoring of this level. It advises setting a minimum percentage of international students that the programme deems necessary to achieve its internationalization goals, and taking measures if the number threatens to reach that point.

Feasibility

The panel studied an overview of the study success for the programme, and discussed its feasibility with the students, teaching staff and programme management. It noted that the dropout rates are relatively high throughout the programme, with roughly 30% leaving in the first year. According to the students, these dropouts can cause inconvenience when they leave behind undermanned project groups. When discussing these dropouts, the programme management showed the panel a high correlation between just satisfactory (5.5-6.5) secondary school grades in mathematics and physics, and a high probability of dropout. The programme tries to discuss this with prospective students in matching interviews, but some register nonetheless and often drop out in the first year. The panel understands that this is mostly outside the programme's control, and encourages the programme to continue its efforts to prevent mismatches between prospective students and the profile of the programme.

With regard to the feasibility of the curriculum, the students indicated to the panel that the workload in the programme can be high. There is a relatively large number of contact hours (20 hours/week), along with the project work and self-study. This can be challenging for first-year students who have to accommodate to the integrated approach of TEM, which requires continuous effort throughout the module. The students indicated to the panel that once they get accustomed to this mode of working, they usually manage within 40 hours per week. They also feel supported by the teaching staff and by their fellow students, with whom there is frequent interaction. The programme management is aware of the experienced workload. It provides counselling to students through the study advisor, and tutors help the project groups to manage their projects in the first year. Module teams, consisting of all teaching staff involved in a particular module, take care that the study load is manageable and evenly distributed over the 10 weeks. Roughly 70% of the students who continue into the second year graduate within the nominal+1 year study duration. According to the programme management, part of this study delay is caused by the relatively high number of students who sign up for extracurricular activities such as the Solar Team Twente. These multidisciplinary, university-wide project teams align well with the goals of Advanced Technology, and the programme encourages students to participate, even though this prolongs their study duration.

The panel considers the feasibility of the programme as positive. The curriculum is challenging but manageable in the designated time. The panel understands the appeal of extracurricular projects for students and thinks that they can be a very valuable experience, even when they cause study delay. Students are supported with becoming acquainted with the teaching methods and working in project teams. The relatively small scale of the programme and the close collaboration between students in the projects create a strong learning community in which students help each other, and have frequent interactions with the teaching staff. To further improve the support of students, the panel suggests considering the introduction of mentoring by staff members in the programme in addition to the support by the study advisor. This would create fixed moments in which each student evaluates his or her progress in the programme, rather than waiting for requests for help on the students' initiative. Finally, the panel notes that the programme has many similarities with small-scale intensive education programmes. It suggests that the programme could investigate to what extent a special distinction Small-Scale and Intensive Education could be beneficial.

Teaching staff
As the programme Advanced Technology is not attached to a specific discipline, the teaching staff consists of a team of lecturers from different faculties. The programme director approaches individual lecturers, faculties or disciplines with requests to participate in education on specific topics. Some lecturers are long-term contributors to the programme, while others participate on a more incidental basis. To achieve coherence in this diverse teaching staff, module teams of all staff involved in a specific module are formed. These teams meet before the start of a module to prepare and align the education within the module. In addition, all teaching staff involved in the programme meet a few times each year in lunch meetings to discuss priorities and developments within the programme. The programme has a small dedicated staff team that manages the programme on a permanent basis, which includes programme management and student support. Lecturers are staff members who are active as researchers in a wide variety of disciplines, some as full or associate professors. They are often assisted in the modules by PhD students who take roles such as project tutor and tutorial supervisor. 70% of the lecturers associated with the programme either holds a University Teaching Qualification (UTQ), is in the process of obtaining one, or has an exemption based on an equivalent qualification.

Students of the programme told the panel that they are very enthusiastic about their teachers. They mentioned in particular the good atmosphere within the programme, and the approachability of the teaching staff, programme management and student support. There are sufficient teaching assistants and tutors, and there is frequent informal interaction between the students and teaching staff, which enhances the community feeling within the programme..

Programme-specific facilities
The programme has a number of programme-specific facilities associated with practicals and project work. They include project rooms, lab spaces, a self-service workshop for working with metals and

plastics, and a Design Lab shared with other programmes where students can do more advanced work such as laser woodcutting, 3D printing and electronics. The panel had the opportunity to visit a number of project rooms and lab spaces during the site visit. Based on its observations and on the students' remarks, it concluded that the facilities are sufficient with regard to projects and practicals.

Considerations
The programme's ILOs have been well translated into a coherent curriculum, structured alongside the principles of the university-wide Twente Education Model (TEM). The panel concludes that TEM fits the multidisciplinary goals of the programme very well by combining fundamental knowledge in science and engineering with skills and integrative projects. Students are able to shape the programme to their own goals and preferences by gradually specializing in a specific discipline in order to prepare for a subsequent master's programme. The modules are designed in module teams consisting of qualified lecturers from several faculties. Course and module goals are explicitly linked to the ILOs, and care is taken to distribute the workload evenly throughout the 10-week module. The students appreciate the good atmosphere within the programme and the accessibility and approachability of their teachers. The panel praises the programme for successfully organizing a coherent multidisciplinary curriculum.

The panel considers the choice for an English language programme well supported in relation to the programme's goals with regard to intercultural skills, and the teaching staff is sufficiently skilled to provide education in English. To be able to continue to realize its intercultural goals, the programme should continue the careful monitoring of its international intake, and take measures to increase this if necessary. With regard to the design of the programme, the panel recommends making the students'programming skills development more explicit by bringing them into a separate learning trajectory, strengthening the attention paid to academic writing (as already planned by the management), and increasing the visibility of individual learning trajectories, for instance through student portfolios. The programme-specific facilities adequately support students during their projects and practicals. The programme is feasible: the workload is reported by students as high but doable. The panel encourages the programme to keep up the attention paid to possible mismatches of prospective students with the programme given the high dropout rate, and to consider the introduction of mentoring to further support students in managing their workload.

Conclusion
Bachelor's programme Advanced Technology: the panel assesses Standard 2 as 'meets the standard '.

Standard 3: Student assessment The programme has an adequate system of student assessment in place.

System of assessment
Each module of the bachelor's programme Advanced Technology has a module assessment plan in which the module learning objectives, their relation with the programme learning goals, and the individual tests within the programme are presented. The plan also describes what assessment methods will be used, and what the rules and regulations are with regard to the tests, such as their contribution to the final grade, compensation rules and the responsible lecturer. The module assessment plan is composed prior to the start of the module by all lecturers in the module team, with an advice provided by the Examination Board. The design principle for the assessment plan is constructive alignment, in which attention is paid to the coherence between teaching and assessment methods in relation to the learning goals. This includes finding valid and reliable assessment methods for each learning goal, formative assessment with feedback halfway through the module, a mix of group and individual assessment, and attention paid to the learning process with sequential tests that follow the learning trajectories throughout the entire curriculum. To maintain the coherence of the programme, the students are encouraged to follow the 15 EC modules as a whole rather than individual courses. This is reflected by giving them a single grade for the entire module. However,

sufficient subgrades remain valid, and the associated parts of the module do not have to be redone when the student does a resit of the module.

The panel concluded that the module assessment plans of the programme utilizes varied assessment methods that fit the learning goals of the modules. These include written exams, presentations, reflection reports and peer feedback. Furthermore, the panel was informed in the interviews that the programme is investing in e-learning, including digital testing. It applauds the initiatives for e-learning / digital testing and thinks that, if implemented well, they could be a good addition to the instructional methods and assessment portfolio of the programme. The panel considers the fact that the module assessment plans are composed by the entire module team through constructive alignment enhances the coherence and validity of the assessment. The rules and regulations are moreover transparently listed for the students. The balance between group and individual assessment is such that students are individually assessed for each of the intended learning outcomes along with group projects. The students confirmed to the panel that free-riding is mostly prevented within the programme, not only through occasional individual testing but also through peer feedback and close tutoring within project groups.

The overview of associated skills and competences per module as presented in the assessment plans is very elaborate and clearly describes the relation between the module and the programme's ILOs. However, the panel thinks that the description of the individual tests could be improved. They are only listed at the moment, and their relation to the learning goals of the module is not described. A full translation from the programme's ILOs into the module learning goals, and next into the individual tests would paint a complete picture of the assessment within each module. The panel understood from the interviews that the programme is already planning to develop the assessment plans further in this direction, a move which it encourages.

Assessment of bachelor's projects
As described under standard 2, the bachelor's project is conducted as a research or design project in one of the university's research groups. Students have to submit a proposal of their bachelor's assignment to the Examination Board, which checks whether the proposal has the required academic level, is appropriate with regard to the goals of the programme, and the proposed supervisor is qualified. The student conducts the project within the research group and completes the assignment with a written report, oral presentation and defence in front of a bachelor's assignment committee. This committee usually consists of a chair (usually a full or associate professor), the student's supervisor and an external member not otherwise associated with the project. After the thesis defence, the committee decides by consensus on three partial grades that culminate in one final grade: scientific quality (40% weight), communication (30% weight), and organisation and cooperation (30% weight). The committee can use a rubric that describes what qualities a specific grade should reflect. These grades, including the motivation, are registered on the bachelor assessment form and given to the student.

The panel is positive about the careful and thorough procedures surrounding the assessment of the bachelor's projects. Using the consensus of three examiners contributes to a valid and reliable assessment of the student’s exit level. The panel studied a number of assessment forms that accompanied the theses it read to determine the realized learning outcomes of the programme. It was positive about the amount of feedback and motivation for the grades, which generally reflected the impressions that the panel members got from reading the theses. At the same time, it thinks that the division into only three categories is rather broad. The associated rubrics are equally broad and specifically mention that they are intended for inspiration only. The panel recommends creating more subcategories associated with the programme’s ILOs, and removing the suggestion that the committee is free to deviate from the rubrics. It thinks that this is important for coherence, as the examiners originate from many different research groups and educational programmes, which might have different interpretations of how a thesis should be assessed. It also recommends standardizing the use of assessment forms in an administrative sense, as it saw both Dutch and English, and both handwritten and digital feedback.

Examination Board
The bachelor's programme Advanced Technology has its own Examination Board, consisting of six members from the different faculties contributing to the programme. The Examination Board ensures the quality of assessment within the programme by advising on the module assessment plans, approving of students' individual plans for specialization in the third year and their bachelor assignment proposal, appointing examiners, and screening the assessment of the bachelor's theses. The Examination Board report in annual reports about their activities, findings, decisions, and advices.

The panel interviewed the Examination Board and studied a number of its annual reports, and concluded that it fulfils its formal tasks in safeguarding the quality of assessment within the programme. Through the checks against the programme's ILOs when approving the individual curricula of students in the third year and the bachelor's assignment, the Board keeps track of the attainment of the ILOs for individual students. The panel thinks that the Board could be more involved in the development of the assessment system within the programme. The Board currently has only an advisory role, but could proactively suggest improvements, for instance based on evaluations and analysis of the current assessment system.

Considerations
The programme has a valid, transparent and reliable system of assessment in place. The assessment methods are varied and show a good balance between individual and group assignments. The module assessment plans provide a clear overview of the module goals and the intended learning outcomes. They could be further improved by explicitly describing how the individual tests relate to the module learning goals. Assessment of the bachelor's thesis has a solid design with a three-person assessment committee. The assessment form in use is adequate, but could profit from more detailed categories related to the intended learning outcomes, a stricter use of the rubric, and standardization of its use. The Examination Board of the programme fulfils its formal tasks and monitors the realization of intended learning outcomes by individual students. With these fundamental aspects covered, its role could be enlarged from an advisory one to a more proactive one in designing the assessment system.

Conclusion
Bachelor's programme Advanced Technology: the panel assesses Standard 3 as 'meets the standard '.

Standard 4: Achieved learning outcomes
The programme demonstrates that the intended learning outcomes are achieved.

Findings

Bachelor assignments
Before the site visit, the panel studied and discussed 15 bachelor assignments of the programme. The panel jointly agreed that the assignment topics concerned applied and advanced technology, covered a wide range of disciplines, in which the students could show their research and academic skills and their proficiency in the associated disciplines, and additionally could demonstrate their ability to use a multidisciplinary approach. The panel also jointly agreed on the finding that the bachelor thesis demonstrated the intended learning outcomes such as the application of research and academic skills and the proficiency in the associated disciplines, and the ability to use a multidisciplinary approach. Also the panel generally agree with the grades provided. The panel was positively surprised that the graduates were able to demonstrate a bachelor's level in specific disciplines based on a multidisciplinary programme, which it considers to be proof of the programme's quality for educating T-shaped professionals. As discussed under Standard 2, the academic writing skills of some graduates could be improved, which the programme is already planning to address.

Performance of graduates
The panel also considers the following graduates' performances as proof of the programme's quality: the differentiation in choices of the mono- and multidisciplinary master programmes entered, the percentage of continuation in PhD programmes, the wide range of research- and engineering jobs chosen, and the high satisfaction of the graduates.

The vast majority of graduates (97%) continues on into a master's programme, either at the University of Twente (69%), elsewhere in the Netherlands (13%) or abroad (15%). Frequently chosen programmes are mechanical engineering, nanotechnology, chemical engineering, and systems & control. According to an alumni survey conducted in 2019, 21% of the programme's graduates continue in a PhD programme after completion of a master's programme. Others find their way into a wide range of jobs, often in research and/or engineering. 95% of the alumni is satisfied or very satisfied with the programme, and 85% would choose the programme again in hindsight. The panel thinks that these results shed a very positive light on the programme. Also, the fact that students are successfully admitted and complete master's programmes in a wide range of fields underlines the realization of the T-shaped professional that the programme aims for.

Considerations
The panel concluded that the bachelor assignments of the programme Advanced Technology are of good quality and convincingly show that the intended learning outcomes of the programme are achieved by the students. Graduates are prepared to enter multi- and monodisciplinary master's programmes in a wide range of fields, and look back positively on the programme.

Conclusion
Bachelor's programme Advanced Technology: the panel assesses Standard 4 as 'meets the standard '.

GENERAL CONCLUSION

The panel judged that the bachelor's programme Advanced Technology offered by the University of Twente meets all the standards of the NVAO assessment framework for limited programme assessment. The panel therefore advises positively about the accreditation of the programme.

Conclusion
The panel assesses the *bachelor's programme Advanced Technology* as 'positive.'.

APPENDICES

APPENDIX 1: DOMAIN-SPECIFIC FRAMEWORK OF REFERENCE

The Domain Specific Frame of Reference (DSFR) for Advanced Technology consists of three parts:
1) The historical context for the development of the programme
2) The requirements set on engineering programmes
3) A comparison of the content of several disciplinary and broad science and engineering programmes

1.1 The historical context for the development of the programme

The most important reason for the initiative of founding the new bachelor programme Advanced Technology (AT) in 2004 was the observation that everything that is designed, planned and produced in modern-day society is part of an interdisciplinary process. Disciplinary bachelor programmes such as mechanical engineering or chemical engineering do not provide students with an interdisciplinary outlook and attitude. Therefore, a new bachelor programme was needed that revolves around the integration of the various disciplines; a programme with a focus on design, which is strongly embedded in a social/societal context. This concept worked as student enrolled are interested in a broad, integrative, technical programme.

The domain in which the bachelor AT finds its place, is that of interdisciplinary academic higher education. The interdisciplinary character is based on the synergy of engineering and social sciences with a keen eye for aspects from social sciences to ensure that technical innovations become feasible. An Advanced Technologist is a true T-shaped professional who is able to look for and find solutions with an eye for the global requirements.

AT is not a replacement, but an addition to the existing, mono-disciplinary, technical programmes, with clear distinguishing features both in contents and organisation. Students can enter the labour market using this basis or decide to continue with a (technical) master at the UT, another Dutch university or a university abroad.

1.2 The requirements set on engineering programmes

1.2.1 3TU AC (Academic Criteria)

The three Dutch technical universities (Delft, Eindhoven and Enschede) cooperate in a confederation. One of the joint activities of this 3TU-confederation is the application of a set of criteria for academic (design) education. These “3TU Academic Criteria” (ACQA), generally known as the Meijers criteria have been adopted by the boards of the 3 TUs and agreed on by NVAO as a replacement for the Dublin Descriptors. These 3TU-criteria are more suitable for technical programmes than the Dublin descriptors. This is why the bachelor Advanced Technology is tested against the ACQA criteria. The full description of the Meijers criteria are given at the end of this chapter.

1.2.2 ASIIN

ASIIN12 is a prominent German accreditation institute for, amongst others, the engineering sciences. This organization has formulated the “ASIIN General criteria for the Accreditation of degree programs” complemented with specifications for specific domains. Of these the specific domains 1) Mechanical engineering, process engineering and chemical engineering, 2) Electrical Engineering and information technology and 3) Physical Technologies, Materials and Processes provide a good representation of engineering programmes.

The engineering programmes have the following common requirements:

- Knowledge and Understanding, with a common and a domain specific component.
- Engineering Analysis
- Engineering Design
- Investigations and Assessment
- Engineering practice
- Transferable skills

The common part is formulated either rather broad as Mathematical and natural sciences fundamentals, e.g. mathematics, physics, computer science (mechanical engineering) or already more specific in terms of Algebra, Analysis, Vector Calculus, Differential and Integral Calculus, functions of several variables, linear equation systems for mathematical components (most elaborately defined for Physical Technologies) and the natural sciences aspects almost always include mechanics, thermodynamics (not EE), measurement, basic electrical engineering and control engineering (not Materials and Processes), heat and material transfer (not EE), fluid mechanics (not EE) and materials science (not EE) and computer science.

All bachelor's programmes in these domains are expected to contain Interdisciplinary contents: Subjects in the area of economics, non-technical elective subjects, (if not already integrated), Self-, time- and project management, team development, communication, languages (if not integrated already in the curriculum), Study projects and of course a bachelor's thesis.

1.2.3. QAA

The British Quality Assurance Agency for Higher Education (QAA) accreditation organization published a Subject Benchmark Statement in 2015 for bachelor's and master's degrees in engineering. This document was intended as a reference framework to establish standards for a diverse range of programmes. It defines the characteristics of engineering graduates as persons that will:

- be pragmatic, taking a systematic approach and the logical and practical steps necessary for, often complex, concepts to become reality
- seek to achieve sustainable solutions to problems and have strategies for being creative, innovative and overcoming difficulties by employing their skills, knowledge and understanding in a flexible manner
- be skilled at solving problems by applying their numerical, computational, analytical and technical skills, using appropriate tools
- be risk, cost and value-conscious, and aware of their ethical, social, cultural, environmental, health and safety, and wider professional responsibilities
- be familiar with the nature of business and enterprise in the creation of economic and social value
- appreciate the global dimensions of engineering, commerce and communication
- be able to formulate and operate within appropriate codes of conduct, when faced with an ethical issue
- be professional in their outlook, be capable of team working, be effective communicators, and be able to exercise responsibility and sound management approaches.

Academic standards for the UK have been formulated by the Engineering Council in the "Accreditation of Higher Education Programmes: UK Standard for Professional Engineering Competence". In this standard, six key areas of learning are defined:

- Science and mathematics
- Engineering analysis
- Design
- Economic, legal, social, ethical and environmental context
- Engineering practice
- Additional general skills

1.2.4 ABET

The Engineering Accreditation Commission of the American Accreditation Board for Engineering and Technology (ABET) organization formulated criteria for accrediting Engineering programs updated for review in 2019-2020.

It requires that the student outcome should assure:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

3. an ability to communicate effectively with a range of audiences

4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

6. an ability to develop and conduct appropriate experimentation, analyse and interpret data, and use engineering judgment to draw conclusions

7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Also strict requirements with regard to the curriculum are put:

(a) a minimum of 30 semester credit hours (or equivalent) of a combination of college-level mathematics and basic sciences with experimental experience appropriate to the program.

(b) a minimum of 45 semester credit hours (or equivalent) of engineering topics appropriate to the program, consisting of engineering and computer sciences and engineering design, and utilizing modern engineering tools.

(c) a broad education component that complements the technical content of the curriculum and is consistent with the program educational objectives.

(d) a culminating major engineering design experience that 1) incorporates appropriate engineering standards and multiple constraints, and 2) is based on the knowledge and skills acquired in earlier course work.

1.2.5 Conclusion

Requirements set by federations and coordinating bodies for engineering bachelors in Germany, the UK, the USA and the Netherlands are quite similar. They all require a certain level of knowledge, skills and attitude as described by the 7 categories defined by the Meijers criteria. These criteria can therefore be used as the benchmark for an academic qualification of bachelors programme.

	Meijers criteria
1	*is competent in one or more scientific disciplines*
2	*is competent in doing research*
3	*is competent in designing*
4	*has a scientific approach*
5	*possesses basic intellectual skills*
6	*is competent in co-operating and communicating*
7	*takes account of the temporal and the social context*

1.3 A comparison of the profiles and content

1.3.1 Bachelors at the UT with a master's programme frequently chosen by AT students

Masters programmes at the University of Twente chosen by 75% of the AT students are:

- Mechanical Engineering (ME)
- Chemical Science and Engineering (CSE)
- Electrical Engineering (EE)
- Applied Physics (AP)
- Sustainable Energy and Technology (SET)
- System and Control (SC)
- Nanotechnology (NT)

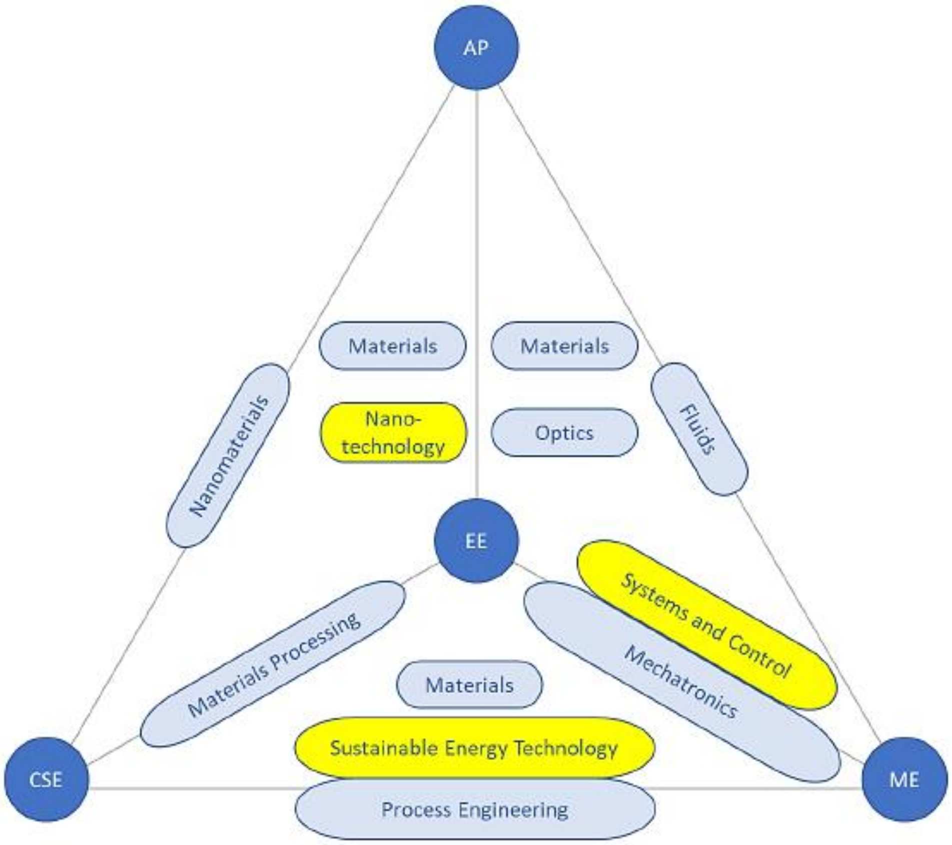


Figure B-1 3D schematic overview of the 4 engineering disciplines at the University of Twente considered in the comparison and the shared multidisciplinary domains. Indicated are the position of the multidisciplinary masters SET, SC and NT.

The first four master programmes on this list have their own associated bachelor's programme, while the other three are multi-disciplinary masters without an associated bachelor's programme. However, these multidisciplinary masters have many courses they share with the four disciplinary masters and students are eligible with a bachelor of at least two of the disciplinary bachelors. This overlap in domains is shown in Figure B-1. In fact, the master thesis of students in one of these multidisciplinary programmes is carried out in research groups that also participate in one of the disciplinary programmes. The requirements on students for these seven mainly chosen master programmes can thus be reduced to the requirements set by the four disciplinary master programmes, which is provided by the four associated bachelors programmes.

The analysis of the common core of the four associated bachelor's programmes Applied Physics (AP), Chemical Science and Engineering (CSE), Electrical Engineering (EE) and Mechanical Engineering (ME) provides a view on what a bachelors AT should at least contain. This common core can be extended by what is found in the majority of these programmes. Table B-1 shows the presence of the topics in these four bachelors programmes.

1.3.2. Profiles of related programme in the Netherlands

Science (Radboud University)

The only other programme in the science and engineering domain that itself as a broad bachelor is the Science programme at the Radboud University in Nijmegen. After a first year with courses from physics, chemistry and life science, the student is expected to choose a combination of two disciplines for the further study. Suggested combination are two fields from the constituting programmes physics, chemistry and life-science. Other combinations with for example mathematics and computer science are within reach. The didactic concept uses so-called panorama courses to give a direct link with current research and innovation. The translation of research to an actual product is part of the third year. The content of this programme (especially the common part) is listed in Table B-1.

Profiles of innovation-oriented programmes in the Netherlands

There are at least 3 bachelors programmes that focus on science, engineering and innovation, Innovation Sciences (TUE), Science, Business and Innovation (VU) and Science and Management of Innovations (Utrecht University). They have chosen a profile which leads to a mixed engineering and science education on the one hand and a strong business and management education on the other hand. This allows their students to assess technological innovations and to formulate requirements set by business and society for a successful introduction of new products and technology. The large focus on business and management has limited the amount of educational time available for science and engineering to about 60 EC. Graduates from these programmes are thus not eligible, or only with a large premaster programmes, for science and engineering masters. The graduates of these programmes are therefore educated with a very different aim and are left out in the comparison.

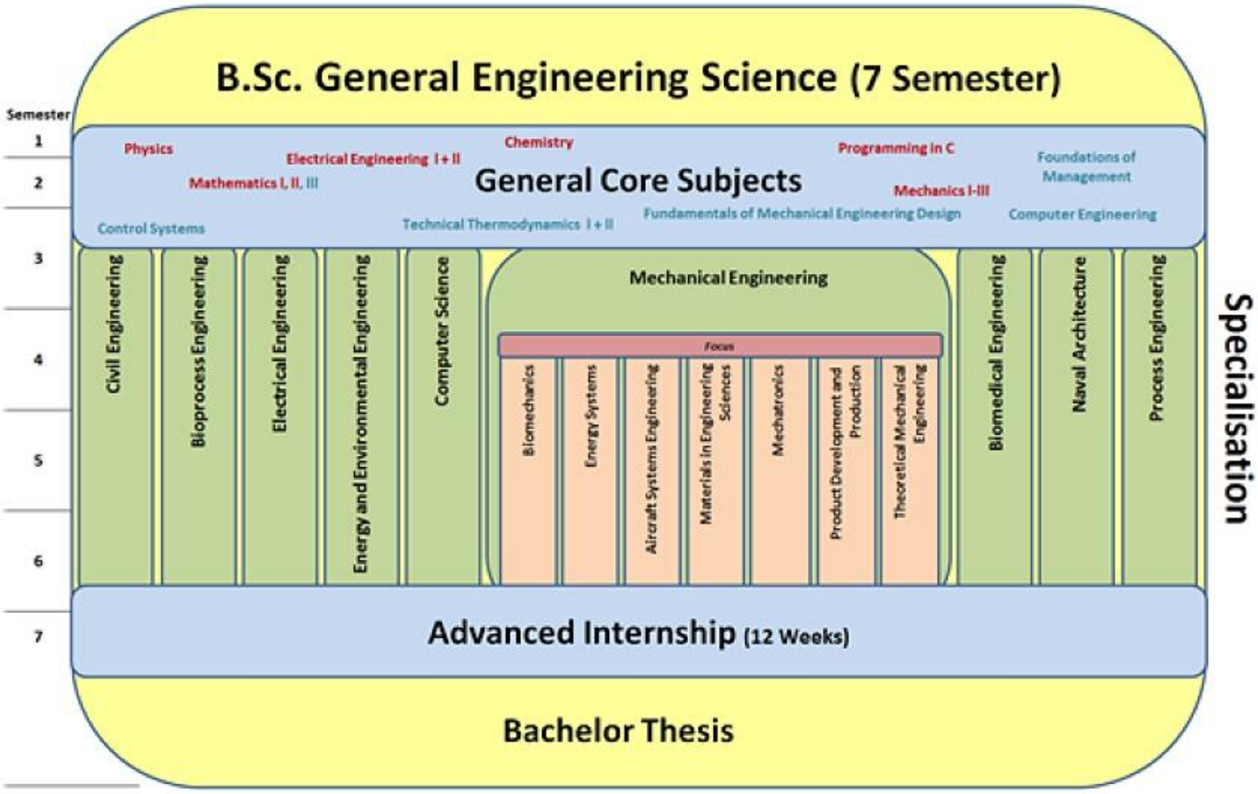
1.3.3. Profiles of related programmes outside the Netherlands

General Engineering Science programme of the Hamburg University of Technology

The Hamburg University of Technology gives a representative example of a curriculum for the bachelor programme 'Allgemeine Ingenieurwissenschaften' (AIW). AIW is a 7-semester programme with nine specialisation tracks after the second semester. The curriculum is organised as follows:

*Curriculum content **		*Specialisation directions*
Mathematics I	8 EC	Civil and Environmental Engineering
Physics for Engineers	4 EC	Bioprocess Engineering
Electrical Engineering I	6 EC	Electrical Engineering
Mechanics I Statics	6 EC	Energy and Environmental Engineering
Chemistry	6 EC	Computer Science and Engineering
Programming in C	2 EC	Mechanical Engineering
Electrical Engineering II	6 EC	Biomedical Engineering
Fundamentals of ME design	6 EC	Naval Architecture
Thermodynamics I	6 EC	Chemical Engineering
Mathematics II	8 EC	
Mechanics II (materials)	6 EC	
Mathematics III	8 EC	
Mechanics III (hydrostatics, kinematics, dynamics)	6 EC	
Thermodynamics II	5 EC	
Internship	18 EC	
Nontechnical complementary	6 EC	
Computer Engineering	within choice	
Control Systems	within choice	
Business Administration	within choice	
Bachelor Assignment	12 EC	

The common part including the Bachelor assignment amounts to 120 EC. This leaves 90 EC for each specialization. The programme has an international counterpart, called General Engineering Science (GES). Most of the courses in the first year of GES are in English. The language of the courses in the various specialization is mainly German. The content of the common part of this programme is also listed in Table B-1.



Engineering Technology of the KU Leuven (English taught)
A common core mainly in the first three semesters (118 EC) on general scientific-technological knowledge and skills from the following domains:

- 25EC Energy and Physics (mechanics, statics, thermodynamics, electromagnetism, material strength)
- 14EC Matter and Chemistry (chemistry and technology of materials)
- 8EC Life and Biology;
- 31EC Information and Mathematics (calculus, linear algebra, signals and systems, statistics, programming, electronic circuits);
- 12EC Management and Communication;
- 14EC Holistic engineering experience;
- A specialization (62 EC) in the last 3 semesters in;
- Electromechanical Engineering Technology;
- Electronics and ICT Engineering Technology;
- Chemical Engineering;
- Biochemical Engineering.

Note that a BSc assignment is not part of the programme.

Ingenieurswetenschappen of the KU Leuven (Dutch taught)
This programme is very similar to the English taught version but differs in a wider selection of specializations. The curriculum consists of a shared first three semester initial phase with elements from math, physics and chemistry, specifically engineering related themes of mechanics, materials science, energy, electromagnetism and programming) as well as elements from the humanoria, economy, philosophy, religion and business administration. In the second year a major and a minor focus is chosen which determines the curriculum of the 3 remaining semesters. The choices are:

- Civil Engineering
- Chemical Technology
- Computer Science
- Electrical Engineering
- Geotechnical and mining
- Materials science
- Mechanical engineering
- Business and Management
- Life and Biology

Note that a BSc assignment is not part of the programme.

APPENDIX 2: INTENDED LEARNING OUTCOMES

The Advanced Technology graduate:

1. Can apply basic theoretical concepts, important methods and techniques in the fields listed below and has skills to increase and develop this through study:
a. Elements from mechanical engineering, electrical engineering, physics, chemistry: Newtonian dynamics, Thermodynamics, Material Science, Mechatronic systems, electromagnetism, System Engineering
b. Mathematics and programming.
c. Innovation, business administration and development/trends of technology on a local and a global level
d. Analysis of impact of technology on a local and a global level.
e. Experimentation in the technical sciences.

2. Research & Design
a. is able to apply the scientific research method.
b. is able to apply the scientific design methods and is able to divide a design problem in different sub problems.

3. Is able to organize work both independently and as a member of an international project group. In project work able to define separate problems for team members, to assure the interconnection between these entities and to implement a timeline.

4. Is capable of communicating on technical-scientific issues both in writing and orally in a clear, concise and professional manner.

5. Is capable of analysing, modelling, interpreting and solving technical -scientific problems with an academic approach, i.e., formulating a problem definition, selecting scientific information and processing it, conducting research and critically evaluating the subsequent results, and of formulating conclusion.

6. Is able to recognize personal strengths and weaknesses as well as personal interests that are necessary to opt for either a follow-on study, in particular an academic master's programme which requires a high level of autonomy or a job in the labour market.

APPENDIX 3: OVERVIEW OF THE CURRICULUM

The figure below shows a schematic overview of the bachelor curriculum of Advanced Technology:

Year 1	Mechanics	Thermodynamics	Fundamentals of Materials	Dynamics
Year 2	Signals, Models & Systems	Electives a) Materials Science & Engineering b) Transport Phenomena, c) Systems and Control	Fields & Waves	Business & Society
Year 3	Preparation for the Master's programme of your choice			Bachelor's assignment

Year 1
The modules of the first year are focused on providing the basic knowledge of science and engineering from the domains of mechanics, process engineering (thermodynamics) and materials science, complemented by an introduction to modelling and understanding the behaviour of dynamical systems. Along these topics a mathematical foundation is made and directly applied, experimental skills are trained, and students are introduced to research and design methodology.

Year 2
The basis laid in the first year is enlarged in the second year with an extension of the modelling skills, signal analysis, application of vector calculus in understanding electromagnetism and the introduction to the complex world of product development where engineering possibilities have to be aligned with business and societal impact and demand. The second year also provides students with the opportunity to make their first choices and with that shape their own programme. The choices in module 6 are limited to 4 topics that are obligatory for more than 90% of the master's choices of AT students: mechatronics and control, process engineering, materials science, and computer science. Students will thus experience whether the content and approach of one of these directions matches their interest and expectations. If not, the students' individual programme can be changed to accommodate a new direction of specialization by taking another choice from these four modules in the third year.

Year 3
In the third year students deepen their knowledge and skills by choosing modules or courses that prepare for admission to a master's programme of choice, inside or outside the University of Twente. This creates a third year that is based on and adapted to the individual choice of each student, who is coached in this process by the study advisor and the secretary of the Examination Board. Hence, the Examination Board plays a formal role as it has to approve the individually shaped programme of each student. The process of choosing a master's and informing students on the consequences for their third year programme already starts in the second year with general information sessions, sessions with representatives of master's programmes and lunch colloquia organized by the study organization Astatine. Furthermore, for 18 master's programmes offered at the University of Twente pathways for entering are available and updated yearly.

The TEM limits the choice of AT students to only take modules of 15 EC, which has several drawbacks: (1) an elective module may contain essential education for master admission and at the same time may consist of already obtained knowledge, and (2) it limits the development of a multidisciplinary breadth in the third year through a larger combination of courses as in modules the focus is on specific themes.

Bachelor’s assignment

The last module of the bachelor’s is the final graduation project, the bachelor’s assignment, in which students individually need to show their knowledge and skills as a T-shaped professional. This graduation project is usually carried out in one of the research groups at the university under the supervision of a daily supervisor and a full or associated professor. Prior to the bachelor’s assignment, a student can participate in the course Preparation Bachelor’s Assignment in which students are guided in the choice of an assignment and have to produce a written introduction to the assignment that clarifies what the assignment is about, why it is relevant, what the international status on the topic is, and what the main research question should be.

APPENDIX 4: PROGRAMME OF THE SITE VISIT

DAG 0

16.30	17.30	Startbijeenkomst en panelinstructie
17.30	19.00	Vooroverleg panel
19.00	21.00	Diner panel (besloten)

DAG 1

08.30	09.00	Aankomst en welkom
09.00	09.45	**Interview inhoudelijk verantwoordelijken**
09.45	10.00	Pauze
10.00	10.45	**Interview studenten**
10.45	11.00	Pauze
11.00	11.45	**Interview docenten**
11.45	12.15	**Rondleiding**
12.15	13.15	Lunch
13.15	13.45	**Interview examencommissie**
13.45	14.15	Intern overleg
14.15	14.45	**Eindgesprek formeel verantwoordelijken**
14.45	15.30	**Ontwikkelgesprek**
15.30	17.00	Opstellen voorlopige bevindingen
17.00	17.15	**Mondelinge rapportage voorlopig oordeel**
17.15	17.30	Afronding

APPENDIX 5: THESES AND DOCUMENTS STUDIED BY THE PANEL

Prior to the site visit, the panel studied 15 theses of the bachelor's programme Advanced Technology. Information on the selected theses is available from QANU upon request.

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):

- Intended learning outcomes
- Curriculum overview, study guide
- Education and Exam Regulations
- Overview of teaching staff
- Module information, materials, exams and assessment plans
- Assessment policy
- Alumni survey May 2019
- Master admission requirements
- Annual Reports Examination Board