Biomedische Technologie

Faculty of Science and Technology,
University of Twente

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CONTENTS

This report was finalized on 4 December 2012.

Report on the bachelor's programme Biomedical Technology and the master's programme Biomedical Engineering of University of Twente

This report takes the NVAO's Assessment framework for limited programme assessments as a starting point.

Administrative data regarding the programmes

Bachelor's programme Biomedical Technology

Name of the programme:	Biomedical Technology
CROHO number:	56226
Level of the programme:	bachelor's
Orientation of the programme:	academic
Number of credits:	180 EC
Specializations or tracks:	
Location(s):	Enschede
Mode(s) of study:	full time
Expiration of accreditation:	31-12-2013

Master's programme Biomedical Engineering

Name of the programme:	Biomedical Engineering
CROHO number:	66226
Level of the programme:	master's
Orientation of the programme:	academic
Number of credits:	120 EC
Specializations or tracks:	1) Molecular, Cellular & Tissue Engineering 2) Human Function Technology
Location(s):	Enschede
Mode(s) of study:	full time
Expiration of accreditation:	31-12-2013

The visit of the assessment committee Biomedische Technologie to the faculty of Science and Technology of University of Twente took place on 13 and 14 September 2012.

Administrative data regarding the institution

Name of the institution:	University of Twente
Status of the institution:	publicly funded institution
Result institutional quality assurance assessment:	applied (pending)

Quantitative data regarding the programmes

The required quantitative data regarding the programmes are included in Appendix 5.

Composition of the assessment committee

The committee that assessed the bachelor's programme Biomedical Technology and the master's programme Biomedical Engineering consisted of:

- Prof. dr. ir. J. Vander Sloten, professor in Engineering Sciences, KU Leuven, Belgium;
- Dr. J. Struijk, associate professor at the Department of Health Science and Technology, Aalborg University, Denmark;
- Prof. dr. ir. J.A.E. Spaan, professor in Medical Physics, Academic Medical Center, University of Amsterdam;
- Prof. dr. R. Reilly, professor in Neural Engineering, Trinity College, Dublin;
- S. van Tienhoven, BSc, master student Biomedical Engineering, Eindhoven University of Technology.

The committee was supported by drs. L. van der Grijspaarde, who acted as secretary.

Appendix 1 contains the curricula vitae of the members of the committee.

Working method of the assessment committee

Preparation
The assessment of the bachelor's programme Biomedical Technology and the master's programme Biomedical Engineering of University of Twente is part of a cluster assessment of seven Biomedical Technology degree programmes offered by four universities. The entire cluster committee consists of six members. The kick off meeting for the cluster assessment was scheduled on 13 September 2012. During this meeting the committee members received an introduction into the assessment framework and evaluation procedures and the committee agreed upon its general working method. Furthermore the domain specific requirements and the most recent developments concerning the Mechanical Engineering domain were discussed. These domain specific requirements and the actual context form the starting point for the evaluation of the quality of the degree programmes.

In preparation of the assessment of the programme a self-assessment report was prepared by the programme management. This report was sent to QANU and, after a check by the secretary of the committee to ensure that the information provided was complete, forwarded to the committee members. The committee prepared the site visit by studying the self-assessment report and a number of bachelor and master theses. The secretary of the committee selected fifteen theses randomly and stratified out of a list of all graduates of the last two years per programme. The following stratification is used: five theses for each degree programme with low grades (6-6.5), five theses with middle ranged grades (7-8) and five theses with high grades. QANU asked the programmes to send the theses including the assessment by the supervisor and examiner and divided them among the committee members; each committee member therefore assessed three theses per programme.

When a thesis was assessed as questionable or unsatisfactory by a committee member, a reassessment was done by another committee member. In the case that more than 10% of the theses were assessed as questionable or unsatisfactory by two committee members the selection of theses for the programme was extended to 25.

Site visit
The committee members formulated questions raised by studying the self-assessment report in advance. These questions were circulated in the committee.

The committee visited the programme on 13 and 14 September 2012**.** The programme of the site visit was developed by the committee's secretary in consultation with the programme management and the chair of the committee. The committee interviewed students, teachers, alumni, the programme management and representatives of the Faculty Board, the Examination Board and the student and teacher members of the Programme committee. An open office hour was scheduled and announced (but not used).

During the site visit the committee studied additional material made available by the programme management. Appendix 7 gives a complete overview of all documents available during the site visit. The last hours of the site visit were used by the committee to establish the assessments of the programme and to prepare the presentation of the findings of the committee to the representatives of the programme.

Report
The secretary wrote a draft report based on the findings of the committee. The draft report has been amended and detailed by the committee members. After approval of the draft report by the committee, it was sent to the Department for a check on facts. The comments by the Department were discussed in the committee, this discussion resulted in some changes in the report and subsequently the committee established the final report.

Decision rules
The assessment was performed according to the NVAO (Accreditation Organization of the Netherlands and Flanders) framework for limited programme assessment (as of 20 November 2011). In this framework a four-point scale is prescribed for both the general assessment and assessment of each of the three standards. The committee used the following definitions for the assessment of both the standards and the programme as a whole.

Generic quality
The quality that can reasonably be expected in an international perspective from a higher education bachelor's or master's programme.

Unsatisfactory
The programme does not meet the current generic quality standards and shows serious shortcomings in several areas.

Satisfactory
The programme meets the current generic quality standards and shows an acceptable level across its entire spectrum.

Good
The programme systematically surpasses the current generic quality standards across its entire spectrum.

Excellent
The programme systematically well surpasses the current generic quality standards across its entire spectrum and is regarded as an (inter)national example.

General assessment

When Standard 1 or Standard 3 is assessed as 'unsatisfactory', the general assessment of a programme is 'unsatisfactory'.

The general assessment of the programme can be 'good' when at least two standards, including Standard 3, are assessed as 'good'.

The general assessment of the programme can be 'excellent' when at least two standards, including Standard 3, are assessed as 'excellent'.

Summary judgement

This report presents the findings and considerations of the committee that assessed the bachelor's programme Biomedical Technology and the master's programme Biomedical Engineering of University of Twente. The committee studied the information available and discussed the programmes with representatives of the institution and the programme during a site visit. The committee weighed their positive comments and the points for improvement found and concluded that the programmes meet the current generic quality standards and shows an acceptable level across its entire spectrum. Therefore, the committee assesses the bachelor's programme Biomedical Technology and the master's programme Biomedical Engineering as 'satisfactory'.

Since 2001, the Faculty of Science and Technology of the University of Twente offers the bachelor's programme Biomedical Technology. In 2004, the first master students commenced the master's programme Biomedical Engineering. The bachelor's programme focusses on the fundamentals in biomedical engineering. The master's programme offers students the opportunity to further strengthen their knowledge and skills in the domain of biomedical engineering. In addition, in the master's programme students specialise in one of the two following tracks: 'Molecular, Cellular & Tissue Engineering' and 'Human Function Technology'. The second track is divided in two sub tracks: 'Health Care Technology' and 'Biomedical Physics'. The Molecular, Cellular & Tissue Engineering track focuses on new materials and tissues suitable for artificial organs/blood vessels and replacements for skin, bone and cartilage. The other track comprise the technology used in diagnostic, therapeutic, rehabilitation and prevention processes.

Standard 1: Intended learning outcomes
The committee assesses Standard 1 as **satisfactory** for the bachelor's and the master's programme.

The objective of the *bachelor's programme Biomedical Technology* and the *master's programme Biomedical Engineering* of the University of Twente is described in the domain statement. According to this domain statement, biomedical engineering is an interdisciplinary field, combining engineering disciplines and natural and life sciences.

The universities offering degree programmes biomedical engineering agreed upon the domain specific requirements. The committee is satisfied with the use of the competence areas of the ACQA as a framework for the seven competences of both programmes.

The competences are elaborated into specific intended learning outcomes for the bachelor's programme Biomedical Technology as well as for the master's programme Biomedical Engineering. According to the committee, these intended learning outcomes are well described in terms of level and orientation and are in line with the domain-specific requirements for biomedical engineering.

The committee established that the bachelor programme intends to offer students a thorough general, broad and up to date education in the field of biomedical engineering. The master programme offers the students the possibility to obtain thorough knowledge, insight and skills in one of the master tracks.

Standard 2: Teaching-learning environment
The committee assesses Standard 2 as **satisfactory** for the bachelor's and the master's programme.

According to the committee, the content and structure of the bachelor's and the master's programme enable the admitted students to achieve the intended learning outcomes. The facilities are adequate for realising the programme. The staff is enthusiastic and supportive for the students.

In September 2010, the bachelor's programme Biomedical Technology started developing a new curriculum for the bachelor's programme and, from September 2011, started implementing the new curriculum gradually. In the new curriculum, the goal is to integrate the subjects of the various mother disciplines. The committee agrees with the programme management that the cohesion of the old curriculum needed improvement in particular in regard to the mathematics courses. The committee regrets however that a lot of the information on the new curriculum only became available during the site visit. At the same time, the committee appreciates that the Biomedical Technology curriculum was acting as a pilot for the new bachelor structure at UTwente.

In the new curriculum, each year consists of four quartiles of 15 EC. Each quartile contains a project, which assigns a number of different tasks linked to the theme of the quartile. The project themes represent major questions of the research profiles. The pedagogical concept of the programme is based on project-based learning, because it offers the possibility to really challenge the students with assignments derived from the societal context of the professional profile.

Vertical and horizontal learning lines are developed for the new curriculum. Vertical learning lines are defined by disciplinary background and levels of competence, horizontal lines are based on the general academic competences. Not all horizontal and vertical learning lines of the new curriculum are fully designed and implemented yet. However, the committee feels the new curriculum has a good balance between theory, practical work and research and design projects. Learning outcomes and competences to be achieved by the students in the courses are built on what was learned previously. The committee feels this teaching-learning concept does structure the programme and is in the view of the committee supportive for the learning process of the students.

The committee is impressed by the clear description of the quartiles in the manuals. Learning outcomes, project assignments, practicals and courses of the quartile are described in a coherent way. In addition, the committee thinks that during the courses, up-to-date scientific literature is used and actual cases in science and technology are regularly incorporated into the various projects throughout the curriculum. Connections with current research developments are also strongly emphasized in project courses, according to the committee.

The goal of the two-year (120 EC) master's programme Biomedical Engineering is twofold: specialization within the biomedical technological area and further scientific professional and personal development. The programme consists of two years of 60 EC each in 40 scheduled weeks divided over two semesters of 30 EC each. Courses are offered in the English language.

The committee has established that the master programme enables the students to develop their competences in biomedical engineering on an advanced level and prepares the students for continuing their studies in a PhD programme or to fulfil a position in the labour market for which an advanced scientific education in biomedical engineering is required. However, the committee agrees with the programme management for the need for a redesign of the master's programme, that is more focused on competences. The committee learned that a new programme is developed with the intention to implement this in 2013-2014.

Another area for improvement is the way the programme is organized. Students have the possibility to shape the programme according to their own individual wishes and interests by choosing courses from a preselected list of 88 courses. The monitoring and the curriculum should focus more on the individual development of the student. Not so much by subjects, but more by deliberate choices based on personal goals. In the new situation, rather than offering a broad range of subjects, students will be supported in deliberately choosing an individualized programme to provide the academic depth and breadth required for biomedical engineering.

Standard 3: Assessment and achieved learning outcomes
The committee assesses Standard 3 as **satisfactory** for the bachelor's and the master's programme.

Within the bachelor's programme Biomedical Technology, a variety of assessment methods are used. The committee examined the learning assessment procedure and looked into a selection of assessments. The committee concludes that assessments are adequately related to the programme. There is a variety of assessment forms and there is a good balance between individual and group assignments.

In the new programme, students receive a mark per quartile but are also assessed on the different courses per quartile. Each quartile students need to make sufficient grades for all assessments but one. For this one a score of minimal five is accepted.

For the new curriculum, assessment matrices ('toetsmatrijzen') are developed per quartile. In these matrices per course, the connection between the learning objectives and the assessment and the weighing factors for all grades is made clear. The committee studied several assessment matrices and concludes these make a contribution to valid assessments.

Within the master's programme Biomedical Engineering, a variety of assessment methods are used. At the master's level, students work closely with their professors and research groups. The committee examined the learning assessment procedure and looked into a selection of assessments. The committee concludes that assessments are adequately related to the programme. However, the transparency of the assessment could be improved, ensuring that all students are objectively assessed according to the same criteria.

The committee has established that both the bachelor's and the master's programme have adequate assessment systems and assessment procedures. The assessment procedures are sufficiently implemented in the programme.

The Board of Examiners performs most of its legal tasks, but does not yet pro-actively control the quality of the exams, the assessment procedures or graduation theses. The committee strongly recommends the Board to develop in a short timeframe a specific plan on how to carry out the assurance of the assessment.

The committee assessed fifteen recent bachelor theses and fifteen master theses and established that all theses met the requirements for graduation. On average the theses are of sufficient quality. The committee has not seen theses that were on the whole unsatisfactory. The theses illustrate that the students have achieved the intended learning outcomes as formulated by the programme. However, some of the master theses were graded on the high side.

In recent years the assessment form used to assess the final assignments of bachelor and master students did not contain grading. The committee strongly recommends to develop a uniform assessment form to be used for assessment of all final assignments. It needs to be clear how the comments on every aspect of the assessment come together in a final grade. In addition, a more systematic use of a scoring chart and the use of own grading descriptions is needed. The committee recommends to make sure this document is well known by the students and staff, and to keep the completed forms as a record. Finally, the committee recommends to develop an assessment form on which every member of the assessment committee can make his or her remarks independently.

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

Bachelor's programme Biomedical Technology:

Standard 1: Intended learning outcomes	satisfactory
Standard 2: Teaching-learning environment	satisfactory
Standard 3: Assessment and achieved learning outcomes	satisfactory
General conclusion	satisfactory

Master's programme Biomedical Engineering:

Standard 1: Intended learning outcomes	satisfactory
Standard 2: Teaching-learning environment	satisfactory
Standard 3: Assessment and achieved learning outcomes	satisfactory
General conclusion	satisfactory

The chair and the secretary of the committee hereby declare that all members of the committee 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: 4 December 2012

Prof. dr. ir. J. Vander Sloten

drs. L. van der Grijspaarde

Description of the standards from the Assessment framework for limited programme assessments

Standard 1: Intended learning outcomes

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

Explanation:
As for level and orientation (bachelor's or master's; professional or academic), the intended learning outcomes fit into the Dutch qualifications framework. In addition, they tie in with the international perspective of the requirements currently set by the professional field and the discipline with regard to the contents of the programme.

Findings

Since 2001, the Faculty of Science and Technology of the University of Twente offers the bachelor's programme Biomedical Technology. In 2004, the first master students started with the master's programme Biomedical Engineering. According to the self-evaluation report, the bachelor's programme focusses on the fundamentals in biomedical engineering. The master's programme offers students the opportunity to further strengthen their knowledge and skills in the domain of biomedical engineering. In addition, in the master's programme students specialise in one of the two following tracks:

- Molecular, Cellular & Tissue Engineering;
- Human Function Technology.

The second track is divided in two sub tracks:

- Health Care Technology;
- Biomedical Physics.

The objective of the bachelor's programme Biomedical Technology and the master's programme Biomedical Engineering of the University of Twente is described in the domain statement. According to this domain statement, biomedical engineering is an interdisciplinary field, combining engineering disciplines and natural and life sciences. Integrating scientific and engineering concepts and methodology, the Biomedical Engineer works to increase scientific knowledge and solve health care problems, by:

- acquiring new knowledge of living systems through continuous innovation and substantive application of experimental, analytical, and design techniques;
- designing and developing new devices, algorithms, processes and systems to advance medical technology in health care;
- solving health care problems through purposeful context-driven problem solving;
- implementing solutions using excellent cross-disciplinary communication and cooperation skills.

In 2005, domain-specific requirements for biomedical engineering in the Netherlands were developed by the biomedical engineering programmes of the Eindhoven University of Technology, the University of Twente and the University of Groningen. Recently, the three original partners and the Technical University Delft confirmed these domain-specific requirements. The domain-specific requirements are presented in Appendix 2. To define competences, the bachelor's programme Biomedical Technology and the master's programme Biomedical Engineering made use of these domain-specific requirements.

The seven competences of the bachelor's programme Biomedical Technology and master's programme Biomedical Engineering are presented below. The competences are the same for both programmes.

A biomedical engineer:

- **has expertise in the discipline of biomedical technology.** A Biomedical Engineer is familiar with existing scientific knowledge and has the competence to expand this knowledge through study.
- **has expertise in research.** A Biomedical Engineer has the competence to acquire new scientific knowledge by research. Here, research means: a goal-oriented and methodical increase of new knowledge and insights.
- **has expertise in design.** A lot of biomedical engineers will design new products. Here, designing means a synthetic activity aimed at the emergence of new or modified artefacts or systems with the intention of creating value in accordance with predefined requirements and needs (e.g. health).
- **has a scientific approach.** A Biomedical Engineer has a systematic approach, characterized by the development and use of theories, models and coherent interpretations, has a critical attitude and understanding of the nature of science and technology.
- **possesses basic intellectual skills.** A biomedical engineer is competent in reasoning, reflecting, and judgment. These are skills learned or sharpened in the context of a discipline and then generically applicable.
- **has expertise in cooperating and communication.** A Biomedical Engineer has the skills to work with or for others. This competence requires adequate interpersonal skills, responsibility and leadership, but also excellent communication with colleagues and non-specialists. He or she is also able to participate in a scientific or public debate.
- **takes into account the temporal and social context.** Science and Technology are not isolated and always have a temporal and social context. Ideas and methods have their origins; decisions have social consequences in time. Biomedical Engineers are aware of this and have the competence to integrate these insights into their scientific work.

The seven competences of the bachelor's programme Biomedical Technology and the master's programme Biomedical Engineering are derived from the seven competence areas of the ACQA (Academic Competences and Quality Assurance) framework 'Criteria for Academic Bachelor and Master Curricula' (Meijers, van Overveld and Perrenet, 2007). This elaboration of the Dublin descriptors, which is widely used by technical universities in the Netherlands, Germany and Belgium, was formally accepted by the NVAO by letter of 29 June 2006. The seven competence areas of the ACQA framework represent the domains of (intended) competence development of BSc or MSc students during their study.

Because the levels on which the competences should be mastered are different for the bachelor's programme Biomedical Technology and for the master's programme Biomedical Engineering, the seven competences are elaborated into intended learning outcomes (final qualifications), different for both programmes. This resulted per programme in a list of five to eight intended learning outcomes per competence. For each intended learning outcome, the programmes indicated whether its emphasis is on knowledge (k), skills (s) or attitude (a). The intended learning outcomes are listed in Appendix 3.

The committee is of the opinion that the intended learning outcomes correspond to general, internationally accepted descriptions of bachelor's and master's qualification. In addition, the committee feels that the intended learning outcomes which have been formulated do meet the requirements which generally apply to a programme in this field of studies. The intended learning outcomes are clearly specified.

The committee feels that the intended learning outcomes apply equally to the existing tracks. With the future tracks on either research or engineering, making the intended learning outcomes more specific may be needed, according to the committee.

Considerations

The committee established that the bachelor programme intends to offer students a thorough general, broad and up to date education in the field of biomedical engineering. The master programme offers the students the possibility to obtain thorough knowledge, insight and skills in one of the master tracks.

The committee is satisfied with the use of the competence areas of the ACQA as a framework for the seven competences of both programmes. The competences are elaborated into specific intended learning outcomes for the bachelor's programme Biomedical Technology as well as for the master's programme Biomedical Engineering. According to the committee, these intended learning outcomes are well described in terms of level and orientation and are in line with the domain-specific requirements for biomedical engineering.

Conclusion

Bachelor's programme Biomedical Technology: the committee assesses Standard 1 as **satisfactory**.
Master's programme Biomedical Engineering: the committee assesses Standard 1 as **satisfactory**.

Standard 2: Teaching-learning environment

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

Explanation:
The contents and structure of the curriculum enable the students admitted to achieve the intended learning outcomes. The quality of the staff and of the programme-specific services and facilities is essential to that end. Curriculum, staff, services and facilities constitute a coherent teaching-learning environment for the students.

Findings

The contents (2.1), the learning environment (2.2), the quantity and quality of the staff (2.3) and the facilities (2.4) of the bachelor's programme Biomedical Technology and of the master's programme Biomedical Engineering are discussed below.

2.1 Contents of the programme

The contents of the bachelor's and of the master's programme are described and discussed separately. In addition, the correspondence between the intended learning outcomes and the programmes has been discussed.

2.1.1 Curriculum of the bachelor's programme Biomedical Technology

The three year bachelor's programme is offered exclusively as a full-time programme of 180 EC.

In September 2010, the programme started developing a new curriculum for the bachelor's programme and, from September 2011, started implementing the new curriculum gradually. In the year 2011-2012, the programme offered the first year of the new curriculum. In September 2012 the second year of the new bachelor's curriculum started. The new curriculum of the first year is now being offered for the second time. The current third year students are offered the old third year curriculum. The new third year curriculum will be offered in the year 2013-2014 to the students who followed the first and second year of the new bachelor's curriculum.

The committee spoke with students who are now in the second year of the new curriculum and who followed the new first year curriculum. In addition, the committee spoke with students who follow(ed) the old bachelor's curriculum.

The old and the new curriculum are discussed below.

<u>Curriculum: old programme</u>

Appendix 4 provides an overview of the old curriculum (third year, 2012-2013).

In the old curriculum, the focus of the first year was on the fundamentals in biomedical engineering. The courses were of a generic nature in the basis of biomedical engineering, including characteristics of materials, technical concepts, and anatomy/physiology. Mathematics was included in each quartile.

In the second bachelor year, the focus was on the functioning of the systems in technology and the human body, mostly the nervous system and the moving apparatus. Students got an insight into the content and problem solving strategies of the various mother disciplines.

The general basis of biomedical engineering in the old curriculum is completed at the start of the third year when the students choose their preliminary specialization, which leads to one of the master tracks: 'Molecular, Cellular and Tissue Engineering' and 'Human Function Technology' ('Biomedical Physics' and 'Health Care Technology').

Based on their preference, students chose a specific research group for their bachelor assignment. They did so based on the information given in colloquia in the second year, information provided by the groups, and reports and presentations given by fellow students. Current third year students reported to the committee that they feel well informed about the master tracks and think they will be well prepared for the master's programme.

According to the self-evaluation report, the old programme had increasing subject complexity and student autonomy. The committee agrees on that, and agrees at the same time with the argumentation of the programme management to develop a new curriculum. For example, the cohesion of the old curriculum needed improvement. The core principles of the technical disciplines could be offered in a more coherent way. The learning lines were not transparent. Each professor formulated his or her own course goals in terms of knowledge. Skills were not always an explicit part of the written learning goals. This impression was strengthened by comments of students of the old curriculum, who reported to the committee that they did not always feel that the courses were offered in a logical sequence and that the integration of learned skills did not always take place. In addition, many students had difficulties with the mathematical courses and it was not always clear to students why they needed mathematics for their engineering competences. Students reported to the committee they missed cases on biomedical engineering in the first bachelor year. Most of the presented cases in courses and projects were submitted from the core disciplines. According to these students, integration of these disciplines was missing.

<u>Curriculum: new programme</u>
Appendix 4 provides an overview of the new curriculum (first and second year, 2012-2013).

In this paragraph, the focus is on the content of the new programme. Changes on the didactical concept are discussed in paragraph 2.2, 'Learning Environment'.

In the new curriculum, the goal is to integrate the subjects of the various mother disciplines. A staff member described the difference to the committee as 'the same stuff in a different way'. For example, the basics of chemistry was explained by textbooks on chemistry. Now, this is taught in a different way: it is more interrelated to the whole curriculum. Anatomy is combined with biochemistry and chemistry for example.

In the new curriculum, each year consists of four quartiles (1 quartile = ½ semester = 10 weeks = 15 EC). Each quartile contains a project, that assigns a number of different tasks linked to the theme of the quartile. The project themes represent major questions of the research profiles. Topics of the project assignments are based on, or derived from, actual cases of scientific experimental and practical work. To promote the scientific attitude, interaction and self-motivation play a key role in the project assignments.

As mentioned above, vertical and horizontal learning lines are developed. Vertical learning lines are defined by disciplinary background and levels of competence. The basis is the existing body of scientific knowledge and artefacts. The student builds knowledge to the level of insight. Based on this insight, the student is able to create a new solution for a problem. The solution is created using the scientific and technological methods mastered through the vertical learning lines. One of the vertical learning lines is mathematics. The idea is to implement this learning line for the university as a whole in a couple of years. The development and implementation started at Biomedical Technology.

The general academic competences are now defined as horizontal learning lines. According to the self-evaluation report, these horizontal learning lines were less transparent in the old curriculum and needed adjustment. The scientific approach and intellectual skills were implicitly taught. In the new programme, the students become acquainted with how scientists work in a research environment or engineers in a professional environment. They learn their skills in simulated environments in laboratories used only for teaching projects. Doing so, they are also assessed on their writing and report skills.

The committee studied the documentation provided by the programme on the learning lines. The documentation made clear that the programme distinguishes five vertical learning lines: mechanical engineering, electronic engineering, biomedical physics, chemical technology and biology. The committee outdated from matrices of different dates that the vertical learning lines are still under construction but that a coherent and logical structure arises. The concept of the horizontal learning lines still needs elaboration. The committee encourages the programme to further develop the concept of horizontal and vertical lines.

The new curriculum strives to include an equal amount of research and design projects. Each project has its own goals for soft skills such as cooperation, academic writing, presentations, awareness of one's own competences. These skills are taught and tested. Research skills are developed in a different way. Students will initially get insight into research method and later into statistical analysis. Gradually students get to understand the concept of carrying out research. Students reported to the committee that they feel well prepared to carry out research in their bachelor theses.

The committee studied the scientific textbooks used to supplement courses and viewed some examples of quartile manuals ('kwartielhandleidingen'). The committee is impressed by the clear description of the quartiles in the manuals. Learning outcomes, project assignments, practicals and courses of the quartile are described in a coherent way. In addition, the committee thinks that during the courses, up-to-date scientific literature is used and actual cases in science and technology are regularly incorporated into the various projects throughout the curriculum. Connections with current research developments are also strongly emphasized in project courses, according to the committee.

In the second year of their study, students can follow a short internship in a hospital or a company as a first introduction to the practical application of biomedical engineering. Students reported to the committee that they appreciate this internship.

Starting from the first year, the study association Paradoks regularly organizes excursions to biomedical enterprises & industries and hospitals in the Netherlands. For highly performing students in their third year (and for master students), an intercontinental study tour of three weeks is organised. Additionally, Paradoks regularly organises lunchtime lectures with invited speakers from the professional practices.

The committee is convinced that in the new curriculum there is sufficient attention for the connection to the practice of biomedical technology.

In the new curriculum, students will also be stimulated to start focusing on their master's specialization. As described in paragraph 2.1.2, the master's programme reflects the three Strategic Research Orientations of the research institute of Biomedical Engineering: 'Neural & Motor Systems', 'Imaging & Diagnostics' and 'Tissue Regeneration'. Each of the first three quartiles will align with a Strategic Research Orientation. Students are able to participate in all three quartiles or choose to participate in one or more quartiles in another discipline.

During the interview with the committee, the students confirmed that the new bachelor curriculum is structured in a cohesive and satisfying way. Learning outcomes and competences to be achieved by the students in the courses are built on what was learned previously. There is, according to the students, no dysfunctional overlapping. The students recognise a clear sequence in the education on mathematics. The mathematics learned in previous courses is applied in following courses, according to the students. Students who are able to compare the old and the new programme, feel that this is one of the clearest improvements in the new programme.

2.1.2 Curriculum of the master's programme Biomedical Engineering
Appendix 4 provides an overview of the curriculum of the master's programme.

The goal of the two-year (120 EC) master's programme is twofold: specialization within the biomedical technological area and further scientific professional and personal development. The programme consists of two years of 60 EC each in 40 scheduled weeks divided over two semesters of 30 EC each. Courses are offered in the English language.

As said before, the master's programme offers two tracks:

- Molecular, Cellular & Tissue Engineering;
- Human Function Technology;
    - Health Care Technology;
    - Biomedical Physics.

The 'Molecular, Cellular & Tissue Engineering' track focuses on new materials and tissues suitable for artificial organs/blood vessels and replacements for skin, bone and cartilage. Students learn which molecular and cellular processes play a major role and how to manipulate these processes. They investigate how the body responds to 'foreign' materials and what to do to prevent rejection responses.

The 'Human Function Technology' track comprises the technology used in diagnostic, therapeutic, rehabilitation and prevention processes. It focuses on improving quality of life through technology to support, improve or even repair bodily functions that have deteriorated, have been damaged or completely lost.

The master's programme reflects the research activities of MIRA, the university's research institute in the area of Biomedical Engineering. MIRA has defined three Strategic Research Orientations:

- Tissue Regeneration;
- Imaging & Diagnostics;
- Neural & Motor Systems.

The table below shows the focus areas of the tracks as they relate to the Strategic Research Orientations.

UT Biomedical SRO areas	Master tracks			
	MCTE	HFT	HFT-Care	HFT-BP
Tissue Regeneration	X			
Imaging & Diagnostics		X		X
Neural & Motor Systems		X	X	

The master's programme includes a number of compulsory as well as elective courses related to the specialization. Each research group publishes a list of recommended courses. Students take this list as their starting point. The traineeship is an assignment at a self-selected health care institute or company related to biomedical engineering.

In the second bachelor year, students obtain information about the tracks ('oriëntaties') to choose in their final bachelor year. Students focus further into the research groups when they search for a Bachelor Assignment. Most students continue their master in the same track. The MIRA website gives information about the research done in each research group and the master website lists the research groups with their recommended courses. According to the self-evaluation report, this information helps the students to prepare for a meeting with one of the professors of the group where they want to do their Master Assignment. Such a meeting results in an individual course list and a preliminary intention on a Master Assignment. Students may have more than one meeting before making a definite choice for a research group.

The course list to choose from contains 88 approved courses (2010-2011). Students choose three track-specific compulsory courses of 5 EC each of the course list. The remaining courses are elected by mutual agreement between the student and the research group where the graduation project will take place. A minimum of 15 EC has to be Biomedical Engineering courses, and a minimum of 10 EC has to be Biomedical courses. In general, a student chooses a sufficient number of courses within the chosen specialization. In addition, the student can choose courses from other specializations, from other departments, or even from other universities. The resulting study programme must be signed by the graduation professor. Each personal course list is then reviewed and approved by the examination board. The committee studied the course list and concluded that students tend to choose for the research oriented courses. Engineering courses are less chosen. The programme management confirmed this observation and described that this is one of the reasons to redesign the programme, which is discussed below.

The goal of the 15 EC internship is to acquire professional biomedical engineering experience, preferably abroad. Together with the supervisor and chair holder, students choose an internship in biomedical engineering research, the health care sector or at a biomedical company. The internship serves a four-fold purpose:

- Gaining experience with carrying out an assignment in a restricted time table;
- Applying previously acquired knowledge and skills;
- Acquiring understanding of the functioning of organizations;
- Becoming acquainted with the potential labour market.

The internship assignment requires approval from a member of the scientific staff. During the internship, the student is supervised by an academic of the institution, who also advises the responsible biomedical engineering scientific staff member in the company on the grading process. Ultimately, the assessment of the internship report is the responsibility of the biomedical engineering scientific staff.

Like the bachelor's programme, the master's programme is undergoing a redesign. The current construct is like mono-disciplinary technical programmes: once students choose a research group, they become the responsibility of the groups' professor. He or she determines their course list and research topic, and is also the main assessor. The only remaining link with the biomedical engineering programme is through a small number of obligatory courses. According to the self-evaluation report, the objective of the redesign is to create more transparency and uniformity in programme, which is in essence interdisciplinary. The committee advises the programme to play a more active role in monitoring and guiding students.

According to the self-evaluation report, another area for improvement is the way the programme is organized. As described above, students can choose from a large number of approved courses, yet the final list is largely predetermined by their supervising professors. By using a different organizing principle – the form rather than the content – there will be a Research master track and an Engineering master track. The Research master will follow the same new curriculum as the Twente Graduate School, and another curriculum will be designed for the engineering track. Students will assemble a more individualized list of courses to match their specialization. The master's restructuring is currently in the design phase, and the process will be completed in 2013.

The committee discussed the planned alterations with the programme management, the students and the staff. The committee agrees with the need for a redesign of the master's programme. The monitoring and the curriculum should focus more on the individual development of the student. Not so much by subjects, but more by deliberate choices based on personal goals. In the new situation, rather than offering a broad range of subjects, students will be supported in deliberately choosing an individualized programme. According to the self-evaluation report, the intention is to develop an improved student tracking system to more closely monitor students.

The committee wondered why the programme wants to make the distinction between a research track and an engineering track. The committee felt that perhaps the engineering track focusses too little on research. The programme management explained that the development of the two tracks is still under discussion. The key intention of the engineering track is to prepare students for a career in industry, instead of a career in research. The programme management assured this track will not be a professional master, there will be a sound body of research. However, the programme is still looking for a correct labelling of the two tracks.

2.1.3 Correspondence between intended learning outcomes and the curricula
The committee studied the programmes of the old and the new bachelor's programme and of the master's programme and concludes that both programmes offer students the possibilities to achieve the necessary knowledge and skills. The intended learning outcomes (competences) of the programme are translated per course into specific learning objectives. However, the committee missed an overview of the correspondence between the intended learning outcomes and the (elements of the) curriculum. It is not made clear how the learning objectives per course meet the intended learning outcomes. For example, how and where is assessed if a master student is able to assume the role of team leader, as is stipulated in the intended learning outcomes. The committee is of the opinion that the connection between

the specific learning objectives per course and the intended learning outcomes could be made even more explicit.

As discussed in the previous paragraph, within the master's programme, students are able to compile their programme by choosing courses from a preselected list. The course list needs to be approved by the exam board. This board checks the amount of compulsory courses on the list. The committee has some doubts on this approval and thereby has doubts on the assurance of the obtaining the intended learning outcomes by all master students. The committee thinks the redesign of the master's programme will solve this uncertainty. Until then, it may be recommended to extend the control of a Committee or Board on the selected courses: there needs to be a thorough check if students are able to meet the intended learning outcomes by the chosen courses.

2.2 Learning environment

The learning environment of the bachelor's programme and of the master's programme is described separately.

2.2.1 Learning environment of the bachelor's programme Biomedical Technology

For the learning environment, the didactical concept, the study load, study duration, and the dropouts are discussed. In addition, the tutoring and study advice, the honours programmes and the admission requirements are treated.

Didactical concept

According to the self-evaluation report, the main purpose of the bachelor education is academic, professional and social development of the student. Development is defined as the increase of knowledge, understanding, skills and attitude. The education programme stimulates, promotes, facilitates and supervises this development. The focus is on solving problems in the field of biomedical engineering. They use the regular teaching methods (lecture, tutorial, laboratory) in the courses.

The old programme consisted of a combination of lectures, tutorials and projects where medical/biological and technological knowledge were presented and integrated. According to the self-evaluation report, there was a need for a dedicated pedagogical concept to be able to integrate the founding disciplines in a more coherent way. Therefore, the programme chooses for project-based learning as the pedagogical concept of the new curriculum, because it offers the possibility to really challenge the students with assignments derived from the societal context of the professional profile. The old curriculum had some aspects of project-based education, but the original goals had slightly faded over the years.

In project-based education, students are able to focus on their interests and define their motivational subjects. The goal for students is to discover their natural talents and build a career based on these talents. According to the self-evaluation report, projects can be highly motivating, especially for students with creative minds who are searching for alternatives. The students are stimulated to develop their creativity. Projects require a goal where students must search for a method, acquire skills and knowledge, accept failure and learn from it, and keep trying until they achieve their goals. They learn through experience and, more importantly, they learn how to answer research and design questions by applying knowledge. Students are rated on the level of complexity of the project and their ability to finish it. This type of education motivates students to learn more about the world, creating the basis for lifelong learning.

In the meeting with the committee, first and second year students reported there is a good balance between theory, practical work and projects. They feel that they are enabled by the projects to apply knowledge and skills to 'real' problems. The quartile manuals give clear descriptions of the intention of the project, the learning objectives and the integration of all courses of the specific quartile. The students report that they work in small groups, guided by a tutor. In the first year, weekly meetings are scheduled. In the second year, students can meet their tutor by appointment. According to the students, they are provided with clear feedback on their project work. In conclusion, the students are very satisfied with the didactical concept of the new programme. Students from the old curriculum report to the committee they would have liked more projects in their programme. The integration of knowledge and skills was not optimal, according to these students.

According to the students, the implementation of the new didactical concept sometimes gave some lack of clarity and start-up problems. Students stated that they were invited to give feedback on the new programme and they saw improvements. The communication, the way lectures were given, the way manuals were written and goals were described, the way teachers were working together did all improve during the first year. Students now know better what to expect.

The committee studied the intentions of the project-based education and discussed the implementation of this concept. The committee feels this teaching-learning concept does structure the programme and is in the view of the committee supportive for the learning process of the students.

<u>Study load, study duration and dropouts</u>
The Course and Examinations Regulations (OER) for the bachelor's programme contain rules for the planned study load per block, per semester and per week (a maximum of 40% contact hours and 10% practical work). Part of the quality assurance system is the monitoring of the actual study load and comparing it to the planned study load (where one EC equals 28 hours of study load). This monitoring is done on a course and block/semester level and not only for regular courses, but also for the bachelor assignment. The outcome of the monitoring is that students mostly state that the actual study load (on course and on block level) is not higher than the planned study load and that there is enough time available for the different courses. Incidental peaks in the actual study load on a per week basis are reported. In those cases the programme staff takes measures to improve the balance between courses.

Most of the students have one year or more of study delay during the bachelor. In the quality surveys students report mainly private reasons for their study delay (private circumstances, jobs, activities in study associations, organizing and participating in the foreign study tour, following extra courses etc.). In combination with the information available at present about dropouts, progress and success rates, the committee concludes that the bachelor's programme is feasible.

The percentage of bachelor students that obtain their bachelor's programme in five years has historically (2001-2005) been around 45%. This figure is a little higher in reality, as there was never a requirement to officially finish the bachelor's programme before starting with courses of the master's programme.

Various measures are currently being implemented to support students and improve their performance. These measures include:

- **Third examination rule**: When a student has not achieved a passing grade after two examination attempts, they are barred from registering for a third attempt until they have discussed their planning with lecturer and/or study advisor, and have received their written permission. The examination board then has to approve this signed request.
- **Student progress evaluation ('bindend studie-advies')**: Students who do not succeed in obtaining 45 EC in their first year are not allowed to continue the programme. This will be implemented UT-wide starting in academic year 2012-2013.
- **UT-wide study planning**: All UT students are expected to maintain a study plan.
- **BSc/MSc separation ('harde knip')**: Students will no longer be allowed to start work on a Master's courses while still enrolled in the bachelor's programme. This will become effective nationwide starting in academic year 2012-2013.

Students reported to the committee that they feel the study load is quite high, but not too high. In the first year, student have about 30 contact hours per week. Student assistants and teachers are helping out in 'werkcolleges', so the students do not have much homework besides the contact hours. In the second and third year the amount of contact hours goes down, in line with the development of a study attitude. The study load remains at approximately 40 hours a week. According to the students, their study duration exceeds the prescribed three years because of extra activities like being a student assistant.

The committee feels that once the described measures have become fully effective, there will be a further decrease of the study duration and increase of the B-performance rate after four years.

The percentage of total dropouts averaged 30%, of which 50-84% was realized in the first year. This has fluctuated over the years due to factors such as differences in intake quality. The programme strives for an average dropout rate of 25% at the most, with dropouts occurring as early as possible in the programme. The new curriculum, third examination rule, BSc/MSc separation and student progress evaluation are all intended to contribute toward this goal.

<u>Tutoring and study advice</u>
The study advisor pro-actively supports student monitoring, study planning and first year mentor coordination. At the start of the bachelor's programme, the student advisor invites each new student for an interview to get acquainted. He monitors the progress of the students, and underachievers are called to account. Likewise, overachievers are recommended for further challenging (e.g. the Honours Programmes). When specific problems exceed the study advisor's competence, the student is referred to specialized departments.

In the new programme, first year tutoring is integrated in the on-going projects. All student (groups) contact their tutor on a weekly basis. The study advisor is involved when necessary. The tutors are trained and have a series of scheduled meetings with each other.

The committee is enthusiastic about the active role of the study advisor and the tutors. Students reported to the committee that they feel well guided and monitored in a structured way. They know where to go when they need support.

<u>Honours programmes</u>
For top students, the University of Twente also offers two additional honours programmes: one for mathematics and one for science and academic practice. The former programme has only been open to students of the bachelor's programme Biomedical Technology since 2011,

and three students per year now take part. The latter programme has increasing attendance by students of the bachelor's programme Biomedical Technology, going from the first student in 2009 to six current participants.

The committee thinks that the possibilities for top students who are interested in additional programs are adequate.

Admission requirements

Students from the VWO with profile Nature & Technology or profile Nature & Health with Mathematics B and Physics are admitted without restrictions.

German secondary school students need English and mathematics on 'abitur' level (German final certificate, equivalent to VWO), whereas from physics and chemistry, one subject should be on 'abitur' level and the other on 'abitur' penultimate year level. Since German students have to master Dutch at bachelor 1 level, the university offers summer school Dutch language courses.

Most enrolling students have just finished the VWO. Some students with a VWO diploma that meet the admission requirements, come from another academic degree programme – at the UT or another university – and are considered 'study switchers' ('overstappers').

A candidate who does not meet the regular admission requirement can still apply for special permission to enter the degree programme by submitting a colloquium doctum declaration that shows that the candidate's knowledge of physics and mathematics is at least comparable to that of the regular VWO graduate with the right profile.

The committee studied the admission requirements and believes there are clear admission requirements for each group of enrolling students.

2.2.2 Learning environment of the master's programme Biomedical Engineering

For the learning environment of the master's programme, the didactical concept, the study load, the study duration, the dropout rate, the tutoring, the study advice and the admission requirements are discussed.

Didactical concept

According to the self-evaluation report, the master's programme offers student-oriented courses that contribute to the development of the so-called engineer's attitude. The biomedical engineer will mostly perform the role of researcher, designer, advisor or consultant.

Within the boundaries of the master, the student designs a personal programme. Courses use traditional teaching methods (lecture, tutorial, laboratory) together with self-study of scientific literature. This way, students become familiar with the heuristic of the specific field of science. For the master's programme, the balance between the various study activities cannot be presented unambiguously because the student has great freedom in choosing courses.

In the internship and during the graduation project, the student works autonomously on an assignment in a professional setting. This introduces the student to research and professional practices. It focuses on research and the design of innovative solutions aimed at moving boundaries in health care. The programme management is encouraged to monitor consistency of the individual student's programmes.

Study load, study duration and dropouts
Most courses are offered and tested within one quartile. Some courses take up an entire semester and are completed in the examination period at the end of the semester. When selecting courses outside the compulsory programme, the student is expected to take into account the schedules of both the compulsory courses and the electives.

More than half the students is able to complete the programme within the allotted two years, and more than 85% manage to do so after one additional year. Ten students have been active for four or more years, making them 'langstudeerders'. Based on this information the committee concludes that the master's programme can be successfully completed within the set time.

The percentage of total dropouts averaged 3% in the first year, and 6% total. This includes students who came from the bachelor's programme and other bachelor's programmes of the University of Twente, as well as side continuants from HBO. The majority of dropouts indicated were HBO students, and were caused by lack of academic and mathematical skills.

Tutoring and study advice
Students reported to the committee that they can get behind easily in the master's programme because of a lack of control and guidance. This is changing now, according to the students. The study advisor now pays extra attention to students with a low average cumulative study speed. More information now spreads under students on how to arrange an internship for example, or how to get a course list.

Special attention is paid to two groups of students that are not familiar with the UT: international master students and students who enrol after their (professional learning) HBO bachelor. For both categories, the programme has a dedicated tutor available: the coordinator internationalisation and the HBO coordinator, respectively. International students are linked to a research group of their preference at their admission in order to get acquainted with the Dutch academic community. The international students are monitored and have a progress meeting with their tutor each block. HBO students are monitored with the same frequency during their pre-master phase.

During the preparation for their internship and during the internship itself, all participating students are supported by the faculty internship coordinator. The coordinator helps them with the search for a suitable internship company. During the internship, the student is coached by a qualified in-company supervisor from the host institute, acting as daily supervisor, and a mentor (staff member) from the university research group that is most closely related to the subject. Outgoing students are registered in SMS (Student Mobility System), which is also used for keeping in contact by e-mail.

Admission requirements
Admission requirements have been formulated for several groups of enrolling students. These are laid down in the Education and Examination Regulations for the MSc degree programme. The Executive Board of the University decides about UT regulations, for example the Transfer Table for UT BSc and MSc degree programmes. The Programme Director decides about the admission of all other students (non-regular students). International students are screened by an Admission Committee consisting of the Programme Director (chairman), the Coordinator Internationalisation and a member of the research group where the student would be hosted. The Board of Examiners decides about the contents of the pre-master and

additional competence programmes. Due to the introduction of the "harde knip" in 2012, the contents of pre-master and additional competence programmes will be modified.

The committee studied the admission requirements and believes they are clear for each group of enrolling students.

2.3 Quality and quantity of staff

Most of the staff members have a PhD degree and participate in scientific research. The execution of all teaching and supervisory tasks is almost completely done by full professors (HL), associate (UHD) and assistant professors (UD). The discipline of Biomedical Engineering has approximately 100 PhD students (AIO's). They sometimes contribute to education, but only for a maximum of 10% of their time. This always takes place under direct responsibility of a staff member, usually their supervisor. Most of the PhD students contribute to the daily supervision of the final bachelor and master assignments. Often, they are involved in projects as group supervisors and in practical courses. In some groups, PhD students are asked for various information campaigns or outreach activities.

Student assistants (senior bachelor students or master students) are brought in as assistants in practical training of the bachelor's programme, for the supervised self-study or for special tasks e.g. to support a lecturer in collecting new exercises for the development of a course.

The amount of time each of these staff members devotes to biomedical engineering cannot exactly be determined. The university lecturers are member of the scientific staff of a faculty and do research, educational and management tasks. The university-wide goal is for a division of 40% / 40% / 20% across these three types of activities.

In both the old and new curriculum, courses are provided by researchers participating in officially recognized research programmes. These researchers, vital to the image of the field, contribute to the development of the field of biomedical engineering. Research activities are organized by MIRA, which is recognized by the Royal Netherlands Academy of Art and Sciences (KNAW, Koninklijke Nederlandse Akademie van Wetenschappen.)

The staff and education policy of the faculty aim to improve the didactic qualities, as well as the educational achievements of individual lecturers. All newly appointed scientific staff members have to qualify themselves for their educational tasks by participating in the lecturer training programme of the UT, the so-called 'UTQ' course. Depending on the staff member's previous experience in education, the training programme is set up based on an agreement with the programme director. This training programme has a study load of 250 hours at the most.

Assessment of educational skills is incorporated in the application procedure for new staff. The programme director is a member of the selection committee for vacancies in the scientific staff and is a member of the search committees for vacancies for full professors. Since 2010, the faculty has only attracted scientific staff in a tenure track position. At the appointment, agreements are made about the educational goals which the tenure tracker has to achieve in the coming years. In their annual performance reviews, teaching tasks are assessed, and an improvement of teaching skills may be recommended. The programme director is a formal assessor in the Tenure Track committee which assesses staff members for promotion. In this manner, teaching experience is given due weight in the career path of the individual members of staff.

The committee studied the information provided on the teaching staff and discussed the quality and quantity of staff in the meetings. Students reported to the committee that it is quite easy to contact the staff. Appointments can easily be made and staff reacts adequate on questions of students. Students do have some comments on the quality of teaching of some staff in the bachelor's programme. Overall, the teaching is sufficient, but there are staff members who do lack didactical skills, according to the students. They suggest these staff members need to be evaluated and trained by professionals or colleagues. This should be monitored closely by the Educational Committee (Opleidingscommissie). Students report that the teaching in the master's programme is sufficient. All the lectures are good, staff members use their own research as a source for lectures and discuss their own research passionately.

The committee noticed that the staff has few expertise on some tracks of the master's programme. The programme management made clear that this is one of the reasons to change the master's tracks.

The committee concludes that the teaching staff is involved in actual research. The staff is enthusiastic and supportive for the students. However, some staff members seem to underachieve on didactical skills and need some training and support.

2.4 Facilities

The facilities of the programmes are mainly situated in three locations. Two larger multifunctional classrooms (the so-called 'year-halls') are permanently available for the first and second year bachelor students. All teaching and other study-related activities (except for practical courses) normally take place in these rooms. Twelve project rooms are available which the programmes share with three other programmes within the faculty.

In their third year, a lot of bachelor students have a workplace in or near the laboratory of the chair where they perform their thesis research. Also in the master's programme, laboratory work is done in the dedicated laboratories of the various research groups associated with MIRA. This direct working relationship between staff and students is generally experienced as motivating and productive.

In the master education all practical work is performed in the laboratories of the research groups. Master students have a workplace in or nearby the laboratory of the chair where they do their research during their thesis work. The student is regarded as a group member, participating in all group activities. According to the self-evaluation report, this direct working relationship between staff and students is generally experienced as motivating and productive.

The committee thinks the facilities are adequate for realising the programme. The three buildings are well equipped with modern facilities. The committee was led around the laboratories and was impressed by the quality and flexibility of the experimental setups with which students can have excellent hands-on experience.

Considerations

According to the committee, the content and structure of the bachelor's and the master's programme enable the admitted students to achieve the intended learning outcomes. The facilities are adequate for realising the programme. The staff is enthusiastic and supportive for the students.

Bachelor programme Biomedical Technology
The bachelor's programme is being redeveloped. The new curriculum of the first year is now being offered for the second time and the new curriculum of the second year is offered for the first time. The current third year students are offered the old third year curriculum. The committee agrees with the argumentation of the programme management to develop a new curriculum. The cohesion of the old curriculum needed improvement. In addition, many students had difficulties with the mathematical courses and it was not always clear to students why they needed mathematics for their engineering competences.

Not all horizontal and vertical learning lines of the new curriculum are fully designed and implemented yet. However, the committee feels the new curriculum has a good balance between theory, practical work and research and design projects. Learning outcomes and competences to be achieved by the students in the courses are built on what was learned previously. The committee feels this teaching-learning concept does structure the programme and is in the view of the committee supportive for the learning process of the students.

The committee is impressed by the clear description of the quartiles in the manuals. Learning outcomes, project assignments, practicals and courses of the quartile are described in a coherent way.

The committee thinks that during the courses, up-to-date scientific literature is used and actual cases in science and technology are regularly incorporated into the various projects throughout the curriculum. Connections with current research developments are also strongly emphasized in project courses, according to the committee. The students recognise a clear sequence in the education on mathematics. The mathematics learned in a previous course is applied in a following course.

Master's programme Biomedical Engineering
The committee has established that the master programme enables the students to develop their competences in biomedical engineering on an advanced level and prepares the students for continuing their studies in a PhD programme or to fulfil a position in the labour market for which an advanced scientific education in biomedical engineering is required. However, the committee agrees with the programme management the need for a redesign of the master's programme. At the moment a new programme is developed with the intention to implement this in 2013-2014. The current construct is like mono-disciplinary technical programmes. The main focus is on research and not so much on competences needed for the labour market, such as design competences or organizational competences.

Another area for improvement is the way the programme is organized. Students have the possibility to shape the programme according to their own individual wishes and interests by choosing courses from a preselected list of 88 courses. The monitoring and the curriculum should focus more on the individual development of the student. Not so much by subjects, but more by deliberate choices based on personal goals. In the new situation, rather than offering a broad range of subjects, students will be supported in deliberately choosing an individualized programme.

The biomedical engineering programme no longer monitors the students within the master's phase, which could be improved, according to the committee.

Conclusion
Bachelor's programme Biomedical Technology: the committee assesses Standard 2 as **satisfactory**.
Master's programme Biomedical Engineering: the committee assesses Standard 2 as **satisfactory**.

Standard 3: Assessment and achieved learning outcomes

The programme has an adequate assessment system in place and demonstrates that the intended learning outcomes are achieved.

Explanation:
The level achieved is demonstrated by interim and final tests, final projects and the performance of graduates in actual practice or in post-graduate programmes. The tests and assessments are valid, reliable and transparent to the students.

Findings

For this standard, the assessment methods (3.1) and the achieved learning outcomes (3.2) of the bachelor's programme Biomedical Technology and the master's programme Biomedical Engineering are discussed.

3.1 Assessment methods

The assessment methods are described separately for the bachelor's programme and for the master's programme.

3.1.1 Bachelor's programme Biomedical Technology

Within the bachelor's programme, a variety of assessment methods are used. The committee examined the learning assessment procedure and looked into a selection of assessments. The committee concludes that assessments are adequately related to the programme. There is a variety of assessment forms and there is a good balance between individual and group assignments.

In the new programme, students receive a mark per quartile but are also assessed on the different courses per quartile. Students need to make sufficient grades for all assessments but one in each year. For this one a score of minimal five is accepted.

For the new curriculum, assessment matrices ('toetsmatrijzen') are developed per quartile. In these matrices per course, the connection between the learning objectives and the assessment and the weighing factors for all grades is made clear. The committee studied several assessment matrices and concluded these make a contribution to valid assessments.

Evaluations (of the old curriculum) show that students are generally satisfied with the way the courses are assessed and with the adequacy of the assessments. The assessments are well connected to the study material and lectures. Moreover, in the course evaluations the students are positive about their entrance qualifications for the various courses. This indicates that the coherence in the curriculum is balanced and the final qualifications of a course are geared to the required entrance qualifications of the next course.

The committee met the Board of Examiners during the site visit and discussed the activities the Board carries out in regard to the quality assurance of the exams. The committee concludes that the Board of Examiners performs most of its legal tasks, but does not yet pro-actively control the quality of the exams, the assessment procedures and graduation theses. Minutes of meetings show that the Board of Examiners still discuss how they should ensure the quality of the assessment and wait for a training on this topic they will receive in October 2012. The committee strongly recommends the Board to develop in short time a specific plan on how to carry out the assurance of the assessment.

3.1.2 Master's programme Biomedical Engineering

Within the master's programme, a variety of assessment methods is used. At the master's level, students work closely with their professors and research groups. The committee examined the learning assessment procedure and looked into a selection of assessments. The committee concludes that assessments are adequately related to the programme. However, the transparency of the assessment can be improved, ensuring that all students are objectively assessed according to the same criteria.

The comments on the Board of Examiners in the paragraph on the bachelor's programme apply for the master's programme as well.

3.2 Achieved learning outcomes

The achieved learning outcomes are described separately for the bachelor's programme and for the master's programme.

3.2.1 Bachelor's programme Biomedical Technology

At the end of the bachelor's programme, the student is immersed in research practice by performing the bachelor assignment in one of the department's research groups. Part of this research assignment is an independent literature search and the creation of a research plan, including formulation of a problem statement, research question, selection of theory and experiments as well as a schedule of research activities.

The assessment comprises a written report and an oral presentation for an academic audience, with the focus on the scientific reasoning and the experimental methods and results. For the assessment, a protocol has been defined. The final assessment is performed by an Assignment committee that consists of at least three members, appointed by the Board of Examiners. This committee is chaired by the chair holder or an associated professor where the student's final assignment was performed. At least one of the members of the Assignment committee must be a staff member from another research group to assure an independent vote and consistency between the assessments.

According to the self-evaluation report, one aspect that needed improvement was the lack of design practice in the bachelor assignment. In the new curriculum this will be incorporated.

The committee assessed fifteen recent bachelor theses and established that all theses met the requirements for graduation. On average the theses are of sufficient quality. The committee has not seen theses that were on the whole unsatisfactory. The theses illustrate that the students have achieved the intended learning outcomes as formulated by the programme.

No assessment form with criteria was handed over to the committee to provide information on how the grades were established. In a discussion with the staff, the management and the Examination Board it became clear to the committee that the students are assessed on several aspects, including the quality of their practical work. The committee strongly recommends to develop a uniform assessment form to be used for all bachelor assignments. In addition, a clear description of the meaning of the several grades, connected to the aspects of the assessment of the bachelor assignment, needs to be developed. The committee was handed over an appendix of the OER with the profiles for final grading, but a more systematic use of a scoring chart and the use of own grading descriptions is needed. The committee recommends to make sure this document is known by the students and staff, and to keep this as a record.

The committee was handed over a new assessment form (Assessment Form Final Assignment Bachelor), which the programme intends to start using for assessing bachelor assignments. Five aspects of assessments are distinguished: research execution (process), literature study, research content (report), report design and lay-out, and presentation. The committee welcomes the use of an assessment form, but recommends to develop an extended form on which every member of the assessment committee makes his or her remarks independently. In addition, it needs to be made clear how the comments on every aspect of the assessment come together in the final grade.

3.2.2 Master's programme Biomedical Engineering

Within the master track, the chair holder formulates a 45 EC graduation project in association with the student. The goal of the graduation project is to carry out a research assignment of a certain scale and complexity. The biomedical engineering graduation project is usually carried out at one of the biomedical research groups of the UT. A small percentage of projects are carried out externally. The aims and monitoring are the same as for projects carried out at the UT, and an internal UT supervisor is always assigned in such cases.

A graduation project committee judges the work done during the graduation project. This committee consists of three members. The first is the 'graduation professor' who holds the final responsibility and chairs the committee. The second is a graduation member of the working unit from which the assignment originates. The third member of the committee originates from a different research group to ensure objective assessment of the final product. The graduation professor is responsible for:

- Appointing the committee based on the stipulations mentioned above;
- Making clear agreements with the student concerning the description of the assignment and the phasing of research and reporting;
- Making agreements about the contents of the course list of the student in connection with the preparation for the graduation project;
- Appointing a member of the committee as a daily mentor/supervisor;
- Making agreements with the institution and supervisor, in case the project is conducted externally;
- Making sure that assessment of the work is done adequately.

The graduation project is valued with a single grade, made up of three components; the evaluation of the work done, the written report and the oral presentation including a discussion with the student afterwards. When a graduation project is carried out in an external organization, a representative of that organization may be added to the assessment committee as an advisor, where appropriate.

The committee assessed fifteen recent master theses and established that all theses met the requirements for graduation. On average the theses are of sufficient quality. The committee has not seen theses that were on the whole unsatisfactory. The theses illustrate that the students have achieved the intended learning outcomes as formulated by the programme. However, the theses are graded on the high side. For example, some theses graded with a nine show a poor structure and lacked a depth in the discussion. Some theses were considered by the committee more in the format of a lab report than that of a master thesis.

Master students and alumni reported to the committee that they did not receive a template on how to write a master thesis. They visited defences of master theses of students to find out how they would be assessed.

No assessment form with criteria was handed over to the committee to provide information on how the grades were established. The comments of the committee on the need of an assessment form, reported in the section on the bachelor's programme, apply equally for the master's programme.

The committee requested for an extra meeting with the graduation professors of four of the fifteen master theses. For these theses, the committee needed argumentation on how the final grades were established. The committee graded these theses as sufficient, but graded significantly lower than the graduation project committees. From the interview with the graduation professors, it became clear that these four students did good or excellent experimental work and worked very independently. Low supervision was needed. The committee understands, but recommends to value the written work in the theses more, so it will not be possible in the future to provide a 9 for a poorly written thesis.

Considerations
The committee has established that both the bachelor's and the master's programme have adequate assessment systems and assessment procedures. The assessment procedures are sufficiently implemented in the programme.

The Board of Examiners performs most of its legal tasks, but does not yet pro-actively control the quality of the exams, the assessment procedures and graduation theses. The committee strongly recommends the Board to develop in short time a specific plan on how to carry out the assurance of the assessment process.

The committee assessed fifteen recent bachelor theses and fifteen master theses and established that all theses met the requirements for graduation. On average the theses are of sufficient quality. The committee has not seen theses that were on the whole unsatisfactory. The theses illustrate that the students have achieved the intended learning outcomes as formulated by the programme. However, some of the master theses are graded on the high side.

No assessment form with accompanying criteria was used in the past years to assess the final assignments of bachelor or master students. The committee strongly recommends to develop a uniform assessment form to be used for all final assignments. It needs to be clear how the comments on every aspect of the assessment come together in a final grade. In addition, a more systematic use of a scoring chart and the use of own grading descriptions is needed. The committee recommends to make sure this document is known by the students and staff, and to keep this as a record. Finally, the committee recommends to develop an assessment form on which every member of the assessment committee can make his or her remarks independently.

Conclusion
Bachelor's programme Biomedical Technology: the committee assesses Standard 3 as **satisfactory**.
Master's programme Biomedical Engineering: the committee assesses Standard 3 as **satisfactory**.

APPENDICES

Appendix 1: Curricula vitae of the members of the assessment committee

Prof. dr. ir. J. (Jos) Vander Sloten obtained his PhD in Applied Sciences with Greatest Honors in 1990 at the KU Leuven. Since 1999 he is Full Professor at the Division of Biomechanics and Engineering Design of the KU Leuven. From 2006 until 2012 he was Programme director of the Master of Science programme in Biomedical Engineering at the same university. Since 2000, Professor Vander Sloten is chair of the CRITTO (Commissie Ruimtelijk Inzicht, Technisch Tekenen en Ontwerpen, Technologisch Instituut, Koninklijke Vlaamse Ingenieursvereniging). He is also a member of the Boards of Custom 8 N.V. (a KU Leuven spin-off company) and Materialise N.V., and is a member of various scientific advisory boards and editorial boards of scientific journals.

Dr. J. (Jan) Struijk obtained his PhD at the Biomedical Engineering Division of the University of Twente in 1992. His thesis was called *Immediate Effects of Spinal Cord Stimulation*. He was Visiting Professor in 1988, at Case Western Reserve University, Cleveland (USA). He was Associate Professor at the Departement of Medical Informatics and Image Analysis at Aalborg University (Denmark). Subsequently, he was Director of Studies, Medicine and Technology, Head of Center for Sensory-Motor Interaction/Motor Control and Neurorehabilitaton Technology, and since 2009 Associate Professor at the Medical Informatics Group, all of the Departement of Health Science and Technology. He also was Chairman and member of several PhD evaluation committees.

Prof. dr. ir. J.A.E. (Jos) Spaan is Emeritus Professor in Medical Physics at the Academic Medical Center of the University of Amsterdam since February 2010. In 1970 he got a degree in Engineering, Physics at TU Eindhoven. In 1976 he obtained his PhD at the same university. His thesis was entitled *Oxygen transfer in layers of hemoglobin solutions*. He had appointments at various universities in the Netherlands: TU Delft, University of Leiden and University of Amsterdam. Professor Spaan also was Secretary General of the International Federation of BioMedical Engineering (1992-1998), Chairman of the Cardiovascular Research Institute Amsterdam (2003-2005) and the first elected president of the European Alliance of Medical and Biological Engineering and Sciences (2005).

Prof. dr. R. (Richard) Reilly got a degree in Biomedical Engineering (1989) and obtained his PhD in Biomedical Signal Processing (1992) at University College Dublin. He is and was researcher and biomedical engineer in various hospitals and institutes. He is currently Full Professor of Neural Engineering at the School of Medicine and School of Engineering of Trinity College Dublin and director of the Trinity Centre for Bioengineering. Professor Reilly also is President of the European Society of Engineering and Medicine (2011-2015).

Ms. S. (Sandra) van Tienhoven, BSc is a master student in Biomedical Engineering at TU Eindhoven. She obtained her BSc-degree in Biomedical Engineering at the same university. She also is assistant of the programme director. She was student member of the education committee and faculty board and member of the faculty council.

Appendix 2: Domain-specific framework of reference

Mission statement Bachelor Biomedical Engineering

Biomedical Engineering is an interdisciplinary field, combining engineering disciplines and natural and life sciences. Integrating scientific and engineering concepts and methodology the Biomedical Engineer works to increase scientific knowledge and solve health care problems, by:

- acquiring new knowledge of living systems through continuous innovation and substantive application of experimental, analytical, and design techniques;
- design and development of new devices, algorithms, processes and systems to advance Medical Technology in health care;
- solving health care problems through purposeful context-driven problem solving;
- implementing solutions using excellent cross-disciplinary communication and cooperation.

Domain-specific reference framework and final qualifications

A. Domain specific requirements for level and orientation of graduates

Biomedical Engineering (biomedical engineering) is an engineering discipline focused at the interface of engineering and life sciences. biomedical engineering education should include basic general engineering requirements (as for example indicated by ABET) and a thorough understanding of life sciences. biomedical engineering programs must demonstrate that their students attain, according to the shared Dublin descriptors:

Knowledge and understanding:

a. Knowledge of the basic disciplines mathematics, sciences, and engineering (mechanical, electrical, and chemical engineering and applied physics) to be applied in the field of Biomedical Engineering in a broader sense; i.e. including directly adjacent fields.
b. Knowledge and understanding of concepts of physiology, (cell-) biology, anatomy, biochemistry, pharmacology and pathology as applicable in the field of Biomedical Engineering.

Applying knowledge and understanding:

c. The capability to apply and integrate advanced mathematics, sciences, and engineering to model and solve complex biomedical problems (see also d).

Making judgments:

d. An ability to conduct scientific research in areas of biomedical engineering and technology that are relevant to the advancement of knowledge and insight into fundamental and applied aspects of health and disease.
    - An ability to make measurements on and interpret data from living systems, addressing problems associated with the interaction between living and non-living materials and systems.
    - An ability to translate a clinical or health-relevant problem or question into an experiment, system, component, or process (design) to meet desired needs and, governed by scientific research or modelling, to advise in issues like clinical research in biomedical engineering, diagnosis and therapy.

Communication:

e. A capability to bridge the gap between fundamental and applied research in biomedical engineering and medical (life) sciences by:
   - Demonstrating an ability to communicate effectively in written and verbal form, and
   - Collaboration in a multidisciplinary setting, which may include clinicians, other healthcare workers and industrialists alike.
f. An awareness of potential societal and ethical implications of scientific research in Biomedical Engineering and, in this context, an ability to critically evaluate the effects of his research.

Learning skills:

g. An ability to develop new concepts within the field of biomedical engineering.
h. An ability to study international scientific research.
i. Recognition of the need for, and an ability to engage in life-long learning.

B. Domain specific requirements of the BSc (Cycle 1) and MSc (Cycle 2) programs

The Bachelor's programmefocuses on general knowledge, based on advanced textbooks and including some aspects informed by knowledge of the forefront of their biomedical engineering specialization, basic skills and solving recognizable problems.

The Master's programmefocuses on deepening theoretical knowledge in one or more specific parts of Biomedical Engineering and provides ample experience in setting up, executing and reporting research and design. It leads to an attitude of scientific involvement.

BSc students acquire knowledge and understanding in:

a. Basic beta disciplines: mathematics, sciences, and engineering (mechanical, electrical, and chemical engineering and applied physics) to be applied in the field of Biomedical Engineering in a broader sense; i.e. including directly adjacent fields.
b. Life sciences: physiology, (cell-) biology, anatomy, biochemistry, pharmacology and pathology as applicable in the field of Biomedical Engineering.

BSc students learn to apply knowledge and understanding:

c. Of mathematics, sciences and engineering to model and solve simple biomedical problems.

BSc students learn to make judgments:

d. Involving the making of measurements on and the interpretation of simple data from living systems, addressing the problems associated with the interaction between living and non-living materials and systems at a basic level.
e. Involving the ability to translate simple clinical or health-relevant problems or questions into an experiment, system, component, or process to meet desired needs and, governed by scientific research or modelling, to advise in issues like clinical research in biomedical engineering, diagnosis and therapy.
f. By demonstrating an awareness of potential societal and ethical implications of scientific research in Biomedical Engineering and, in this context, an ability to critically evaluate the effects of his research.

BSc students learn to communicate:

g. By bridging the gap between fundamental and applied research in biomedical engineering and medical (life) sciences by:
   - Demonstrating an ability to communicate effectively in Dutch in written and verbal form, and
   - Collaboration in a multidisciplinary setting.

BSc students acquire learning skills:

h. As demonstrated in their recognition of the need for, and an ability to engage in lifelong learning at the BSc+ level with a high level of autonomy.

MSc students acquire knowledge and understanding:

a. Of in depth biomedical engineering, in a coherent set of specialties, that builds on the basic knowledge acquired in the Bachelor's phase, and that provides a basis or opportunity for originality in developing or applying ideas in this specialization.

MSc students learn to apply knowledge and understanding:

b. In order to apply and integrate advanced mathematics, sciences and engineering knowledge as well as specialized knowledge to model and solve complex biomedical problems in new and unfamiliar environments.

MSc students learn to make judgments:

c. In an ability to conduct scientific research in areas of biomedical engineering and technology that are relevant to the advancement of knowledge and insight into fundamental and applied aspects of health and disease.
   - An ability to make measurements on and interpret complex data from living systems, addressing the complex problems associated with the interaction between living and non-living materials and systems, and the ability to successfully recognize and address new problems in this field.
   - An ability to translate a complex, not well-defined, clinical or health-relevant problem or question into an experiment, system, component, or process to meet desired needs and, governed by scientific research or modelling, to advise in issues like clinical research in biomedical engineering, diagnosis and therapy.

MSc students learn to communicate:

d. With a capability to bridge the gap between complex fundamental and applied research in biomedical engineering and medical (life) sciences by
   - Demonstrating the ability to communicate effectively in written and verbal form in Dutch and English, by underpinning knowledge and rationale (restricted scope) to specialist and non-specialist audiences alike, and
   - Collaboration in a multidisciplinary setting, which may include clinicians, other healthcare workers and industrialists alike.
e. An awareness of potential societal and ethical implications of scientific research in Biomedical Engineering and, in this context, an ability to critically evaluate the effects of the research carried out under his responsibility.

MSc students acquire learning skills

f. An ability to study international scientific research.
g. Recognition of the need for, and an ability to engage in life-long learning at MSc+ level in a manner that may be largely self-directed or autonomous.

Appendix 3: Intended learning outcomes

A Biomedical Engineer:

1. has expertise in the discipline of biomedical technology

A Biomedical Engineer is familiar with existing scientific knowledge and has the competence to expand this knowledge through study.		
	BACHELOR	**MASTER**
1a.	Understands the knowledge base of physics, mathematics technology, biology, physiology and medicine (theories, methods, techniques). [ks]	Has a thorough mastery of a specific field of biomedical engineering extending to the forefront of knowledge (latest theories, methods, techniques and topical questions). [ks]
1b.	Understands the structure of engineering and life sciences, and the connections between sub-fields. [ks]	Looks actively for structure and connections with biomedical engineering in the relevant fields of physics, mathematics technology, biology, physiology and medicine. [ksa]
1c.	Has knowledge of and some skill in the way in which truth-finding and the development of theories and models take place in biomedical engineering. [ks]	Has knowledge of and skill in the way in which truth-finding and the development of theories and models take place in a specific field of biomedical engineering. Has the skill and the attitude to apply these methods independently in the context of more advanced ideas or applications. [ksa]
1d.	Has knowledge of and some skill in the way in which interpretations (texts, data, problems, results) take place in biomedical engineering. [ks]	Has knowledge of and some skill in the way in which interpretations (texts, data, problems, results) take place in biomedical engineering. Has the skill and the attitude to apply these methods independently in the context of more advanced ideas or applications. [ksa]
1e.	Has knowledge of and some skill in the way in which experiments, gathering of data and simulations take place in biomedical engineering and its supporting disciplines. [ks]	Has knowledge of and some skill in the way in which experiments, gathering of data and simulations take place in biomedical engineering and its supporting disciplines. [ksa] Has the skill and the attitude to apply these methods independently in the context of more advanced ideas or applications. [ksa]
1f.	Has knowledge of and some skill in the way in which decision-making takes place in biomedical engineering. [ks]	Has knowledge of and some skill in the way in which decision-making takes place in biomedical engineering. Has the skill and the attitude to apply these methods independently in the context of more advanced ideas or applications. [ksa]
1g.	Is aware of both the presuppositions of the standard methods and their importance. [ksa]	Is able to reflect on standard methods and their presuppositions; is able to question these; is able to propose adjustments, and to estimate their implications. [ksa]
1h.	Is able (with supervision) to spot gaps in his own knowledge, and to revise and extend knowledge through study. [ks]	Is able to spot gaps in his own knowledge independently, and to revise and extend knowledge through study. [ksa]

2. has expertise in research

A Biomedical Engineer has the competence to acquire new scientific knowledge by research. Research means here: a goal-oriented and methodical increase of new knowledge and insights.		
	BACHELOR	**MASTER**
2a.	Is under supervision able to reformulate ill-structured biomedical research problems. [ks] Is able to defend the new interpretation against involved parties. [ksa]	Is able to reformulate ill-structured biomedical research problems of a complex nature. Also takes account of the system boundaries. [ksa] Is able to defend the new interpretation against involved parties. [ksa]
2b.	Is observant, and has the creativity and the capacity to discover certain connections and new viewpoints. [ksa]	Is observant, and has the creativity and the capacity to discover in apparently trivial matters certain connections and new viewpoints and is able to put these viewpoints into practice for new applications. [ksa]
2c.	Is able (with supervision) to produce and execute a research plan. [ks]	Is able independently to produce and execute a research plan. [ks]
2d.	Is able to work at different levels of abstraction. [ks]	Given the process stage of the research problem, chooses the appropriate level of abstraction. [ksa]
2e.	Understands the importance of other disciplines (interdisciplinarity), especially those of the basic engineering discipline and the life sciences. [ka]	Is able, and has the attitude to draw, where necessary, upon other disciplines in his own research. [ksa]
2f.	Is aware of the changeability of the research process through external circumstances or advancing insight. [ka]	Is able to deal with the changeability of the research process through external circumstances or advancing insight. [ksa] Is able to control the process on the basis of this. [ksa]
2g.	Is able to assess research within biomedical engineering on its usefulness. [ks]	Is able to assess research within biomedical engineering on its scientific value. [ksa]
2h.	Is able (with supervision) to contribute to the development of scientific knowledge in one or more areas of the disciplines involved in biomedical engineering. [ks]	Is able to independently contribute to the development of scientific knowledge in one or more areas of biomedical engineering. [ksa]

3. has expertise in design

Many biomedical engineers will design new products. Designing means here a synthetic activity aimed at the emergence of new or modified artefacts or systems with the intention of creating value in accordance with predefined requirements and needs (e.g. health).		
	BACHELOR	**MASTER**
3a.	Is able to reformulate simple ill-structured design problems. Also takes account of the system boundaries. [ks] Is able to defend this new interpretation against the parties involved. [ksa]	Is able to reformulate ill-structured biomedical design problems of a complex nature. Also takes account of the system boundaries. Is able to defend this new interpretation against the parties involved. [ksa]
3b.	Shows some creativity and skills in synthesis with respect to design problems. [ksa]	Shows creativity and skills in synthesis with respect to biomedical design problems. [ksa]
3c.	Is able (with supervision) to produce and execute a design plan. [ks]	Is able independently to produce and execute a design plan. [ks]
3d.	Is able to work at different levels of abstraction including the system level. [ks]	Given the process stage of the design problem, chooses the appropriate level of abstraction. [ksa]
3e.	Understands the importance of other disciplines (interdisciplinarity) and their contribution to the design process. [ks]	Is able, and has the attitude, where necessary, to draw upon other disciplines in his own design. [ksa]
3f.	Is aware of the changeability of the design process through external circumstances or advancing insight. [ka]	Is able to deal with the changeability of the design process through external circumstances or advancing insight. Is able to steer the process on the basis of this. [ksa]
3g.	Is able to integrate existing knowledge in a design. [ks]	Is able to formulate new research questions on the basis of a biomedical design problem. [ks]
3h.	Has the skill to evaluate design decisions in a systematic manner. [ks]	Has the skill to take design decisions, and to justify and evaluate these in a systematic manner. [ksa]

4. has a scientific approach

A Biomedical Engineer has a systematic approach, characterized by the development and use of theories, models and coherent interpretations, has a critical attitude and understanding of the nature of science and technology.		
	BACHELOR	**MASTER**
4a.	Is inquisitive and has an attitude of lifelong learning. [ka]	Is able to identify and take in relevant developments. [ksa]
4b.	Has a systematic approach characterized by the development and use of theories, models and interpretations. [ksa]	Is able to critically examine existing theories, models or interpretations in the area of his or her biomedical engineering MSc track. [ksa]
4c.	Has the knowledge and the skill to use models for research and design and assess their value ('model' is understood broadly: from mathematical model to scale-model). [ks] Is able to adapt models for his own use. [ks]	Has great skill in, and affinity with, the use, development and validation of models; is able consciously to choose between modelling techniques. [ksa]
4d.	Has insight into the nature of life sciences and technology (purpose, methods, differences and similarities between scientific fields, nature of laws, theories, explanations, role of the experiment, objectivity etc.) [k]	Has insight into the nature of life sciences and technology (purpose, methods, differences and similarities between scientific fields, nature of laws, theories, explanations, role of the experiment, objectivity etc.) and has some knowledge of current debates about this. [k]
4e.	Has some insight into scientific practice (research system, relation with patients and other clients, publication system, importance of integrity etc.) [k]	Has insight into scientific practice (research system, relation with clients, publication system, importance of integrity etc. [ksa]) and has knowledge of current debates about this. [k]
4f.	Is able to document adequately the results of research and design. [ksa]	Is able to document and publish adequately the results of research and design with a view to contributing to the development of knowledge in his or her field of biomedical engineering and beyond it. [ksa]

5. possesses basic intellectual skills

A biomedical engineer is competent in reasoning, reflecting, and judgment. These are skills learned or sharpened in the context of a discipline and then generically applicable.		
	BACHELOR	**MASTER**
5a.	Is able (with supervision) critically to reflect on his or her own thinking, decision making and acting, and able to adjust these on the basis of this reflection. [ks]	Is able critically and independently to reflect on his own thinking, decision making, and acting and to adjust these on the basis of this reflection. [ksa]
5b.	Is able to reason logically within biomedical engineering and beyond: both 'why' and 'what-if' reasoning. [ks]	Is able to recognize fallacies. [ks]
5c.	Is able to recognize modes of reasoning (induction, deduction, analogy etc.) within biomedical engineering. [ks]	Is able to recognize and apply modes of reasoning (induction, deduction, analogy etc. [ksa]) within the field. [ksa]
5d.	Is able to ask adequate questions, and has a critical yet constructive attitude towards analysing and solving simple problems in biomedical engineering. [ks]	Is able to ask adequate questions, and has a critical yet constructive attitude towards analysing and solving complex biomedical real-life problems in the field. [ksa]
5e.	Is able to form a well-reasoned opinion in the case of incomplete or irrelevant data. [ks]	Is able to form a well-reasoned opinion in the case of incomplete or irrelevant data, taking account of the way in which that data came into being. [ks]
5f.	Is able to take a standpoint with regard to a scientific argument in biomedical engineering. [ksa]	Is able to take a standpoint with regard to a scientific argument in his or her area of the biomedical engineering and is able to assess critically its value. [ksa]
5g.	Possesses basic numerical skills, and has an understanding of orders of magnitude. [ks]	Possesses basic numerical skills, and has an understanding of orders of magnitude. [ksa]

6. has expertise in cooperating and communication

A Biomedical Engineer has the skills to work with or for others. This competence requires adequate interpersonal skills, responsibility and leadership, but also excellent communication with colleagues and non-specialists. He or she is also able to participate in a scientific or public debate.		
	BACHELOR	**MASTER**
6a.	Is able to communicate in writing in Dutch about the results of learning, thinking and decision-making with colleagues and non-colleagues including health care providers and patients. [ks]	Is able to communicate in writing about research and solutions to problems with colleagues, non-colleagues and other involved parties including health care providers and patients in English. [ksa]
6b.	Is able to communicate verbally in Dutch about the results of learning, thinking and decision making with colleagues and non-colleagues including health care providers and patients. [ks]	Is able to communicate verbally about research and solutions to problems with colleagues, non-colleagues and other involved parties including health care providers and patients in English. [ksa]
6c.	Is able to follow debates about both biomedical engineering and the place of biomedical engineering in society. [ks]	Idem to above (verbally and in writing), but in a second language. [ksa]
6d.	Is familiar with professional behaviour. This includes: drive, reliability, commitment, accuracy, perseverance and independence. [ksa]	Is able to debate about both biomedical engineering and the place of biomedical engineering in society. [ksa]
6e.	Is able to perform project-based work: is pragmatic and has a sense of responsibility; is able to deal with limited sources. [ksa]	Is characterized by professional behaviour. This includes: drive, reliability, commitment, accuracy, perseverance and independence. [ksa]
6f.	Is able to work within an interdisciplinary team of medical and engineering people. [ks]	Is able to perform project-based work for complex projects: is pragmatic and has a sense of responsibility; is able to deal with limited sources; is able to deal with risks; is able to compromise. [ksa]
6g.	Has insight into, and is able to deal with, team roles and social dynamics. [ks]	Is able to work within an interdisciplinary biomedical team having great diversity. [ksa]
6h.		Is able to assume the role of team leader. [ks]

7. takes into account the temporal and social context

Science and Technology are not isolated and always have a temporal and social context. Ideas and methods have their origins; decisions have social consequences in time. Biomedical Engineers are aware of this and have the competence to integrate these insights into their scientific work.		
	BACHELOR	**MASTER**
7a.	Is able to analyse and to discuss the social consequences (economic, social, cultural) of new developments in relevant fields with colleagues and non-colleagues. [ks]	Understands relevant (internal and external) developments in the history of biomedical engineering. [ksa] This includes the interaction between the internal developments (of ideas) and the external (social) developments. Integrates aspects of this in scientific work. [ksa]
7b.	Is able to analyse and to discuss the ethical and the normative aspects of the consequences and assumptions of scientific thinking and acting with colleagues and non-colleagues (in research, designing and applications). [ks]	Is able to analyse and to discuss the social consequences (economic, social, cultural) of new developments in relevant fields with colleagues and non-colleagues. Integrates aspects of this in scientific work. [ksa]
7c.	Has an eye for the different roles of biomedical engineering professionals in society. [ks]	Is able to analyse the consequences of scientific thinking and acting on the environment and sustainable development. Integrates aspects of this in scientific work. [ksa]
7d.	Is able to analyse and to discuss the ethical and the normative aspects of the consequences and assumptions of scientific thinking and acting with colleagues and non-colleagues (both in research and in designing). Integrates these ethical and normative aspects in scientific work. [ksa]	Is able to analyse and to discuss the ethical and the normative aspects of the consequences and assumptions of scientific thinking and acting with colleagues and non-colleagues (both in research and in designing). Integrates these ethical and normative aspects in scientific work. [ksa]
7e.	Chooses a place in society as a professional person. [ksa]	Chooses a place in society as a professional person. [ksa]

Appendix 4: Overview of the curricula

Bachelor's programme Biomedical Technology

First year new programme (B1 of propedeusejaar) 2012-2013

SEMESTER 1-1		SEMESTER 1-2	
Kwartiel 1 (1A)	Kwartiel 2 (1B)	Kwartiel 3 (2A)	Kwartiel 4 (2B)
De maakbare mens – construeren met moleculen	Microscopische detectie van kanker	Meten is weten, basisprincipes van medische sensoren	Adapterende botten, belastingen op en rond implantaten
15EC, 201100172	15EC, 201100184	15EC, 201100215	15EC, 201100227
Kwartielcoördinator: J. Paulusse	Kwartielcoördinator: J. Alers	Kwartielcoördinator: B. van Beijnum	Kwartielcoördinator: J. Homminga
Onderdelen: Project Algemene chemie P. Dijkstra Biochemie F. Coenders Anatomie/fysiologie I. Stoyanova Wiskunde E. Brinksma, H. Aarts, H. Meijer	**Onderdelen:** Project Geometrische optica S. Manohar Celbiologie J. Alers Wiskunde G. Post, H. Meijer	**Onderdelen:** Project Medische sensoren en meetsystemen B.J. van Beijnum Anatomie/fysiologie T. van Wessel Fysische optica S. Manohar Wiskunde H. Aarts, G. Jeurnink	**Onderdelen:** Project Mechanica J. Homminga Harde materialen L. Winnubst Beeldvorming K. Slump Anatomie/fysiologie T. van Wessel Wiskunde: G. Zwier

Second year new programme (B2) 2012-2013

SEMESTER 1-1		SEMESTER 1-2	
Kwartiel 1 (1A)	Kwartiel 2 (1B)	Kwartiel 3 (2A)	Kwartiel 4 (2B)
201200175	Code volgt	Code volgt	Code volgt
Kwartielcoördinator: J. Alers	Kwartielcoördinator: R. Hagmeijer	Kwartielcoördinator: W. Steenbergen (onder voorbehoud)	Kwartielcoördinator: C. Heida (onder voorbehoud)
Thema: **Creating Biological Tissues**	Thema: **Transport phenomena in biological systems**	Thema: **Imaging Technologies**	Thema: **Smart Prosthetics**
Project Fysische chemie van de levenswetenschappen D. Stamatialis / M. Claessens Toegepaste Celbiologie M. Karperien Wiskunde A. Zagaris	Project Massa and Heat Transfer R. Hagmeijer / F. de Jongh Methodologie van modelleren Wiskunde 2 EC A. Zagaris	Project Medische Imaging Fysische Optica Fysiologisch systeemmodelleren Anatomie & Fysiologie Signalen en Systemen	Project Mechanica Systeemanalyse Neurofysiologie Methodologie van ontwerpen

Third year old programme (B3): oriëntatie moleculaire-, cellulaire- en weefseltechnologie 2012-2013

<table>
<tr><th colspan="2">SEMESTER 3-1</th><th colspan="2">SEMESTER 3-2</th></tr>
<tr><th>Kwartiel 1 (1A)</th><th>Kwartiel 2 (1B)</th><th>Kwartiel 3 (2A)</th><th>Kwartiel 4 (2B)</th></tr>
<tr><td rowspan="2">Mechanica van Technische en Biologische Materialen
191150300
(5 EC, Homminga)</td><td colspan="2">Cel- en Weefseltechnologie (+ BMPO)
192731100
(7.5 EC, Karperien/Post)</td><td rowspan="6">Bacheloropdracht
192730888
(15 EC)</td></tr>
<tr><td rowspan="2">Analytische Chemie
191360020
(2 EC, Gardeniers)</td><td>Voorbereiding Bacheloropdracht
192730890
(2.5 EC, Alers)</td></tr>
<tr><td rowspan="2">Molecuulspectroscopie
191360135
(5 EC, Otto)</td><td rowspan="2">Reactiekinetiek en Katalyse van Biochemische Processen
192750000
(5 EC, Seshan)</td></tr>
<tr><td>Bio-Organische Chemie
191320550
(3.5 EC, Dijkstra)</td></tr>
<tr><td>Structuuranalyse
191360260
(2 EC, Velders)</td><td>Biomedische Sensoren
201100139
(2.5 EC, Olthuis)</td><td rowspan="2">Polymeerchemie en Biomaterialen
192713040
(5 EC, Grijpma)</td></tr>
<tr><td colspan="2">Imaging
191211340
(5 EC, Slump)</td></tr>
</table>

Third year old programme (B3): oriëntatie Functieherstelttechnologie 2012-2013

<table>
<tr><th colspan="2">SEMESTER 3-1</th><th colspan="2">SEMESTER 3-2</th></tr>
<tr><th>Kwartiel 1 (1A)</th><th>Kwartiel 2 (1B)</th><th>Kwartiel 3 (2A)</th><th>Kwartiel 4 (2B)</th></tr>
<tr><td>Mechanica van Technische en Biologische Materialen
191150300
(5 EC, Homminga)</td><td>Vectoranalyse,
191510861
(5 EC, v.d. Meer)</td><td>Voorbereiding Bacheloropdracht
192730890
(2.5 EC, Alers)</td><td rowspan="6">Bacheloropdracht
192730888
(15 EC)</td></tr>
<tr><td rowspan="2">Biomedische Signaalanalyse (BSIG, incl. practicum)
191211700
(5 EC, Rutten/van Beijnum)</td><td>Biomedische Sensoren
201100139
(2.5 EC, Olthuis)</td><td>Bio-elektriciteit
191211390
(3 EC, Heida)</td></tr>
<tr><td>Informatiesystemen voor BMT
192720010
(2.5 EC, Sikkel)</td><td>Inleiding Stromingsleer
191154131
(3.5 EC, Hagmeier)</td></tr>
<tr><td colspan="2" rowspan="2">Imaging
191211340
(5 EC, Slump)</td><td>Mechanica van het Bewegingsapparaat
191150491
(2.5 EC Rouwkema)</td></tr>
<tr><td rowspan="2">Arbeid & Fysieke Aspecten vd Mens.
192730011
(3.5 EC, van de Belt)</td></tr>
<tr><td colspan="2">Numerieke Algoritmen en Modelleren
191540280
(5 EC, Zwier)</td></tr>
</table>

Third year old programme (B3): suboriëntatie Functieherstelttechnologie – Zorgtechnologie 2012-2013

<table>
<tr><th colspan="2">SEMESTER 3-1</th><th colspan="2">SEMESTER 3-2</th></tr>
<tr><th>Kwartiel 1 (1A)</th><th>Kwartiel 2 (1B)</th><th>Kwartiel 3 (2A)</th><th>Kwartiel 4 (2B)</th></tr>
<tr><td>Complexiteit van Zorgprocessen
192730120
(5 EC, Oosterwijk)</td><td>Kwaliteit en Veiligheid van Zorg
194112280
(5 EC, Siesling)</td><td>Voorbereiding Bacheloropdracht
192730890
(2.5 EC, Alers)</td><td rowspan="5">Bacheloropdracht
192730888
(15 EC)</td></tr>
<tr><td rowspan="2">Biomedische Signaalanalyse (BSIG, incl. practicum)
191211700
(5 EC, Rutten/van Beijnum)</td><td>Biomedische Sensoren
201100139
(2.5 EC, Olthuis)</td><td>Mechanica van het Bewegingsapparaat
191150491
(2.5 EC Rouwkema)</td></tr>
<tr><td>Informatiesystemen voor BMT
192720010
(2.5 EC, Sikkel)</td><td>Telemedicine Methods
192730500
(5 EC, Jones)</td></tr>
<tr><td colspan="2">Imaging
191211340
(5 EC, Slump)</td><td rowspan="2">ICT toepassingen in Organisaties
194105030
(5 EC, Spil)</td></tr>
<tr><td colspan="2">Numerieke Algoritmen en Modelleren
191540280
(5 EC, Zwier)</td></tr>
</table>

Third year old programme (B3): suboriëntatie Functiehersteltechnologie - Biomedische Fysica 2012-2013

<table>
<tr><td colspan="2">SEMESTER 3-1</td><td colspan="2">SEMESTER 3-2</td></tr>
<tr><td>Kwartiel 1 (1A)</td><td>Kwartiel 2 (1B)</td><td>Kwartiel 3 (2A)</td><td>Kwartiel 4 (2B)</td></tr>
<tr><td>Molecuulspectroscopie
191360135
(5 EC, Otto)</td><td>Vectoranalyse,
191510861
(5 EC, van der Meer)</td><td>Voorbereiding Bacheloropdracht
192730890
(2.5 EC, Alers)</td><td rowspan="5">Bacheloropdracht
192730888
(15 EC)</td></tr>
<tr><td rowspan="2">Biomedische Signaalanalyse (BSIG, incl. practicum)
191211700
(5 EC, Rutten/van Beijnum)</td><td>Biomedische Sensoren
191402052
(2.5 EC, Kooyman/Olthuis)</td><td>Mechanica van het Bewegingsapparaat
191150491
(2.5 EC Rouwkema)</td></tr>
<tr><td>Informatiesystemen voor BMT
192720010
(2.5 EC, Sikkel)</td><td>Bio-elektriciteit
191211390
(3 EC, Heida)</td></tr>
<tr><td colspan="2">Imaging
191211340
(5 EC, Slump)</td><td>Inleiding Stromingsleer
191154131
(3.5 EC, Hagmeier)</td></tr>
<tr><td colspan="2">Numerieke Algoritmen en Modelleren
191540280
(5 EC, Zwier)</td><td>Lineaire Algebra voor BMT
200900002
(3.5 EC, Al-Dhahir)</td></tr>
</table>

Master's programme Biomedical Engineering

Each research group publishes a list of recommended courses. Students take this list as their starting point, and agree on a personal course list with their professor.

The course list contained 88 approved courses (2010-2011), but many of these were only attended by a few students per year. Below is a listing of the most frequently selected courses (10 students or more per year on average). The categories in the first column are:

C = Compulsory (3 courses per track, 15 EC)
M = Biomedical (a minimum of 10 EC have to be chosen from this group)
B = Biomedical engineering (minimum 15 EC)
E = Engineering

Category	Course code	Course name	Teaching Staff	EC	Quarter	MCTE	HFT	HFT Care	HFT BMPh
B	191150390	Biomechanics	Koopman/de Jongh	5	2		x		
B	191150480	Human Movement Control	van der Kooij / Asseldonk / Schouten	5	3		x		
B	191150700	Integrative Design of Biomedical Products	Hekman / Verkerke / Homminga	5	4		c	c	x
M	191150710	Clinical Rehabilitation and Technology	Rietman	5	2		x	x	
M	191154740	Biophysical fluid dynamics: the respiratory system	de Jongh	5	1		x	x	x
B	191211120	Lab on a Chip	van den Berg / Carlen / Eijkel / le Gac	5	4	x	x		
B	191211130	Neurotechnology	Rutten	5	3		x		
B	191211160	Biomechatronics	Veltink / Koopman / Schouten / van der Kooi / Rietman	5	4		x	x	
B	191211310	Technology for the Support of Human Functions	le Feber / Veltink	5	1		c	c	c
B	191211470	Home Care Technology	Hermens / Vollenbroek - Hutten	5	3		x	c	
M	191350435	Advanced Cell Biology	de Boer	5	2	x			
M	191350440	Practical course on Cell Biology	de Boer	5	3	x			
M	191531330	Medical Statistics & Epidemiology	Albers	5	2	x	x	x	
B	193400111	Bionanotechnology	Bennink	5	3	x			
B	193500000	Biomedical Optics	Steenbergen / Leeuwen / Manohar	5	4	x	x		x
B	193542040	Non-invasive Diagnostics	Steenbergen / Slump / ten Haken	5	3	x	c		c
B	193640020	Biophysical Techniques & Molecular Imaging	Subramaniam / Otto	5	2	c	x		c
B	193640040	Tissue Engineering	van Blitterswijk	5	4	c			
M	193640050	Clinical Chemistry	Doelman / Vermes	5	4	x			
M	193640060	Radiation Expertise	Knoopers / Jonkergouw	5	3	x	x		x
M	193640070	Clinical Safety and Quality Assurance	Vaartjes	5	3	x	x	x	x
B	193640080	Biophysics	Claessens	5	1	x	x		x
S	19364088	International studytour	Paradoks/Alers	5	-	x	x	x	x

Category	Course code	Course name	Teaching Staff	EC	Quarter	MCTE	HFT	HFT Care	HFT BMPh
	193640999	Internship biomedical engineering	Various/ Folkers (coordinator)	15	-	c	c	c	c
	193650999	Master assignment biomedical engineering	Various/Alers (coordinator)	45	-	c	c	c	c
E	193735060	Colloids and Interfaces	Lammertink	5	1	x			
B	193737020	Biomaterials for Hard Tissue Replacement	Winnubst	5	4	x			
B	193740010	Controlled Drug and Gene Delivery	Engbersen	5	2	x			
B	193740020	Biomedical Materials Engineering I	Moroni	5	1	c			
B	193740030	Biomedical Materials Engineering II	Feijen	5	3&4	x			
M	194111220	Clinical efficacy and MTA	IJzerman	5	1		x	x	
M	200900040	Topics in Human Anatomy & Sports physiology	Rietman / Reenalda	5	4	x	x	x	

The list of courses with fewer than 10 participants was as follows:

Category	Course code	Course name	Teaching Staff	EC	Quarter	MCTE	HFT	HFT Care	HFT BMPh
E	191102140	Design Tools	Vaneker	5	4		x		
E	191121710	Composites	Warnet/Akkerman	5	2&3		x		
E	191121720	Design, Production and Materials	Akkerman / Warnet / de Rooij / Bor / Schipper	5	2&3		x		
E	191131700	System Identification and Parameter Estimation	Aarts	5	3&4		x		
B	191150460	Biomechanical Engineering - Capita Selecta	Koopman	5	-		x		
E	191156500	Elastomeric Technology	Noordermeer / Dierkes	5	-	x			
E	19115651X	Capita Selecta Elastomer Technology Engineering	Noordermeer / Dierkes	5	-	x			
E	191157110	Introduction to the Finite Element Method	Meinders	3.5	1		x		
E	191157710	Numerical Methods in Mechanical Engineering	van den Boogaard / Meinders / van der Weide	5	1&2		x		
E	191157730	Computational Structural Optimization	Geijselaers	5	4		x		
E	191157740	Advanced Dynamics	van der Hoogt / Wolbert / de Boer	5	1		x		
E	191157740	Control Engineering	van Amerongen / Stramigioli	5	3		x		
B	191210720	Biomedical Signal Acquisition	Olthuis	5	3		x	x	
B	191210901	Introduction to Biometrics	Veldhuis	5	1		x		
E	191210910	Image Processing and Computer Vision	van der Heijden	5	3		x		
E	19150527X	Mathematical Modelling II	Vink-Timmer	5	2		x		x
E	191506001	Mathematical Methods	Krystul	5	2		x		x
E	19152025X	Theory of Complex	Bokhove / Jeurnink	5	4		x		x

Category	Course code	Course name	Teaching Staff	EC	Quarter	MCTE	HFT	HFT Care	HFT BMPh
		Functions							
E	19153044X	Regression and Analysis of Variance	Poortema	5	3		x		x
E	191531351	Statistical Techniques	Poortema	5	1			x	
E	191531450	Linear Statistical Models	Poortema	5	4			x	
E	191551150	Numerical Techniques for PDE	Bokhove	5	2		x		x
E	19155116X	Applied Finite Element Methods for PDE's	Bokhove / van der Vegt	6	3&4		x		x
E	191551200	Scientific Computing	Bochev	6	3&4		x		
E	19156056X	Introduction to Mathmatical Systems Theory	Stoorvogel	5	4		x		
E	191560671	Robust Control	Meinsma	5	3		x		
E	191571090	Time Series Analysis	Zwart	5	1		x		
E	191800671	Management of Technology	Hummel	5	1			x	
E	192110371	Graphics & Virtual Reality	Zwiers	5	2		x	x	
E	192340070	Computer Supported Co-operative Work	Sikkel	5	2			x	
E	192340101	Implementation of IT in Organizations	Muntslag / Katsma	5	3			x	
B	19236050X	E-Health Strategies	Spil	5	4			x	
E	192620010	Mobile and Wireless Networking	Heijenk	5	3			x	
B	192631000	Mobile E-health application and services	Beijnum / Widya	5	3		x	x	
E	192640020	Business Process Engineering	Kroese (extern)	5	4			x	
E	192652150	Service-oriented Architecture with Web Services	van Sinderen / Ferreira-Pirez	5	3			x	
B	193530050	Magnetic Methods for (Neuro) Imaging	ten Haken / Bennink	5	4		x		x
B	193542070	Medical Acoustics	de Jong/Versluis	5	4		x		x
E	193570010	Advanced Fluid Mechanics	van der Meer	5	1		x		x
E	193572010	Physics of Bubbles	Versluis	2.5	2		x		x
E	193580020	Experimental Techniques in Physics of Fluids	Sun / Tagawa / Versluis	5	3&4		x		x
B	193640010	Selected topics biomedical engineering	Various/Alers	5	-	x	x	x	x
E	193640130	Nuclear and Solid State Physics	Harkema	5	1		x		x
E	193730040	Polymers and Material Science Practice	Hempenius / Vancso	3	1	x			
E	193700050	AMM-project Organic Materials	Hempenius	5	3	x			
B	193735040	Biomedical Membrane Applications	Stamatialis	5	2	x			
E	193735050	Membrane Technology Laboratory	Stamatialis	5	4	x			
E	19374004X	Organic Chemistry of Polymers	Feijen	5	-	x			
M	193742000	C.S. Biomedical Chemistry	Engbersen	5	-	x			
E	193770060	Corrosion and Corrosion Resistance	Lammertink	5	3	x			

Category	Course code	Course name	Teaching Staff	EC	Quarter	MCTE	HFT	HFT Care	HFT BMPh
B	193820030	Reconstruction and Visualisation	Slump/van der Heijden	5	2		x		
E	194111180	Effective Health Care Technology	Oudshoorn / Dorkbeck-Jung	5	2			x	
E	194111500	Innovation and Technology Dynamics	Faems / Kuhlmann	5	3			x	
B	19411204X	International Health Strategy & Hospital of the Future	van Harten	5	3			x	
B	194112110	Health and Health Systems	Vondeling	5	2			x	
E	194120040	Organising Innovation	Faems / Groen	5	2			x	
M	194112160	Organisational Aspects of Applying Medical Technology	Hummel	5	2			x	
E	201000182	Management of Technology in Healthcare	Hummel	5	1			x	

Appendix 5: Quantitative data regarding the programmes

Data on intake, transfers and graduates

Total number of students 2005 - 2010

	2005	2006	2007	2008	2009	2010
BSc	185	173	180	169	183	190
MSc	6	53	84	110	96	106

Bachelor's programme Biomedical Technology

Bachelor's intake 2005 – 2010

	2005	2006	2007	2008	2009	2010
Total intake per September 1st	62	53	48	62	68	81
Female	15	22	15	22	27	40
	24%	42%	31%	35%	40%	49%
German	0	1	5	6	10	13
Criterion group[(1)]	45%	46%	43%	47%	57%	50%

Dropouts per cohort BSc

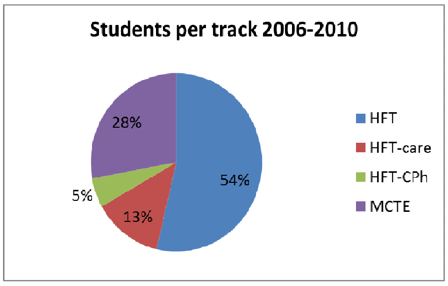
Cohort		Cumulative Drop-out		
Year	**number of students**	**after 1 year**	**after 2 years**	**until March 2012**
2005	62	21%	37%	42%
2006	53	21%	21%	28%
2007	48	21%	23%	27%
2008	62	16%	19%	32%
2009	68	13%	22%	25%
2010	81	21%		25%

Average P and B performance over the period 2005-2010

Cohort			Propedeuse			Bachelor			
cohort	size	remaining P/B students	P diploma ≤ 1 year	P diploma ≤ 2 years	P diploma completed	B diploma ≤ 3 years	B diploma ≤ 4 years	B diploma ≤ 5 years	BSc completed
2005	62	1 / 8	23%	44%	57%	3%	11%	31%	44%
2006	53	3 / 7	30%	57%	72%	6%	34%	49%	49%
2007	48	5 / 14	40%	45%	68%	6%	34%		34%
2008	62	12 / 26	34%	45%	53%	7%			7%
2009	68	28 / 24	31%	48%	48%				
2010	81	55 / 9	35%		35%				
Average			**32%**	**48%**	**56%**	**6%**	**26%**	**40%**	**34%**

BSc Graduates 2003 – 2011

Academic year	BSc intake	BSc graduates	Percentage to BME Master
2002	126	79	90%
2003	96	55	95%
2004	62	35	89%
2005	62	27	85%
2006	53	26	88%
2007	47	16	88%
Averages	74	40	89%



Master's programme Biomedical Engineering

Master's intake 2005 – 2010

Cohort	Cohort size	From BMT	From other UT BSc	From HBO	Internatio nal
2004	24	96%	4%	0%	0%
2005	54	96%	4%	0%	0%
2006	47	84%	0%	16%	0%
2007	65	81%	6%	9%	3%
2008	34	82%	9%	3%	6%
2009	42	88%	8%	3%	3%
2010	49	75%	16%	0%	10%
Average	**45**	**86%**	**7%**	**4%**	**3%**

Percentage of students per track MSc

Cohort	HFT	MCTE	HFT-BP	HFT-Care
2008	27%	36%	15%	21%
2009	57%	19%	5%	19%
2010	33%	27%	18%	21%
Average	**39%**	**27%**	**13%**	**20%**

MSc performance

Cohort		Performance				Study rate	
Cohort	**Cohort size**	**M diploma ≤ 2 years**	**M diploma ≤ 3 years**	**M diploma ≤ 4 years**	**MSc complete**	**Still active**	**% still active**
2004	24	46%	96%	100%	100%	0	0%
2005	54	61%	87%	93%	93%	1	2%
2006	47	53%	79%	83%	83%	0	0%
2007	65	60%	82%		86%	4	6%
2008	34	59%			74%	5	15%
2009	42				31%	26	62%
2010	53				2%	49	93%
Average	**46**	**56%**	**86%**	**92%**			

Dropouts per cohort MSc

Cohort		Cumulative Drop-out		
Cohort	**Cohort size**	**after 1 year**	**after 2 years**	**until April 2012**
2004	24	0%	0%	0%
2005	54	6%	6%	6%
2006	47	4%	11%	11%
2007	65	2%	5%	8%
2008	34	0%	9%	9%
2009	42	5%	5%	5%
2010	53	2%		2%
Average	**46**	**3%**	**6%**	**6%**

Total number of MSc graduates 2005 – 2010

	2005	**2006**	**2007**	**2008**	**2009**	**2010**
Male	1	6	20	23	29	19
Female	2	9	23	19	28	13
	67%	60%	53%	45%	49%	41%
Total	3	15	43	42	57	32

Teacher-student ratio achieved

Student-lecturer ratio for the past three years (BSc and MSc programmes combined)

Calendar year	Primary lecturers	Total lecturers incl. secondary, guest, etc.	Registered students	MSc graduates	Students per primary lecturer	Graduates per primary lecturer
2008	75	104	279	39	3,7	0,5
2009	80	126	279	46	3,5	0,6
2010	77	114	296	45	3,8	0,6

Average amount of face-to-face instruction per stage of the study programme

17 hours of face-to-face instruction per week.

Appendix 6: Programme of the site visit

Thursday 13 September 2012

15.00-18.15	Voorbereidende startvergadering	
18.15-18.30	Presentatie Heleen Miedema	
18.30-19.00	Bezoek aan practica ruimten Carre verdieping	Drs. H.A.T. Miedema en dr. J.C. Alers

Friday 14 September 2012

08.30-09.30	Inzage documenten	
09.30	Gesprek Management	Dr. A.H. Flierman – President Executive Board University of Twente Prof.dr. G. van der Steenhoven – Dean Faculty Science & Technologie Drs. H.A.T. Miedema – Director of Education Biomedical Engineering Drs. K. Haijkens – Manager of Education Biomedical Engineering Drs. L.S. Bergmans – Education coordinator Biomedical Engineering
10.30-11.30	studenten BMT/BME	Bachelor BMT 1e jaar Anne ten Dam Peter Bartels (ook studentlid OLC BMT) Bachelor BMT 2e jaar Nik Huis in 't Veld Anne Luchtenberg Bachelor BMT 3e jaar - Track Arthur Vogelzang – HFT BPh. Alien Stevens – HFT Master BME 1e Jaar - Track Gerrit Held – HFT Elmar Gool – MCTE Master BME 2e jaar - Track Kaj Gijsbertse – HFT

		Maurice van Dalen – MCTE
11.30- 12.30	docenten	Dr. J.C. Alers Prof.dr. P.J. Dijkstra Ir. E.E.G. Hekman Dr.ir. J. J. Homminga Prof.dr.ir. C.H. Slump Prof.dr.ir. W. Steenbergen Prof.dr.ir. P.H. Veltink Prof.dr. M.M.R. Vollenbroek
12.30- 13.00	OLC	Dr.ir. D. van de Belt (voorzitter) Dr.ir. J. Le Feber Dr.ir. S. Manohar Dr. M.M.A.E. Claessens Lisette Alfring Dagmar Grob Ingrid Schut
13.00- 13.30	extra meeting with graduation professors	Dr ir Jasper Homminga Prof. Dr. Miriam Vollenbroek-Hutten Dr. Ir. Bennie ten Haken Prof. Dr. Marcel Karperien
13.45- 14.30	Examencommissie en studieadviseur	Prof.dr.ir. H.F.J.M. Koopman (voorzitter) Dr.ir. J.S. Kanger Prof.dr. H.B.J. Karperien Prof.dr. W.L.C. Rutten Ir. T. van Dam Drs. L.S. Bergmans (ab actis)
14.30- 15.00	Alumni	Nathalie Groen MSc. – PhD- TR Group UT Björn Harink MSc. – PhD-TR Group UT Bram Koopman MSc. – PhD-Biomechanical Engineering (BW) Group Koen Snijders MSc.– Biomedical Engineer Gelre Ziekenh Apeldoorn Wieke van Vuuren MSc. – Mechatronic System Engineer DEMCON Te Oldenzaal. Han Zuidinga MSc. – Health Care IT advisor – KPMG Breukelen.
15.30- 16.15	Eindgesprek Management	
18.00- 18.45	Mondelinge rapportage en informele afsluiting	

Appendix 7: Theses and documents studied by the committee

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

Bachelor's programme Biomedical Technology

0162868	0128775	0162892	0142670
0170224	0184748	0143154	0110736
0149217	0162922	0162876	0167479
0110620	0162884	0162841	

Master's programme Biomedical Engineering

0045780	0073423	0017140	0032964
0115290	0183091	0054801	0086460
0092436	0181501	0063177	0086444
0126861	0037737	0089834	

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

- On Blackboard (Bb) were many documents available to view. Including minutes of meetings and other documents of the 'Examencommissie BMT BME' and 'OpleidingsCommissie BMT' and evaluations:

Notulen	2006	2007	2008	2009	2010	2011	2012
Examencommissie	Bb	Bb	Bb	Bb	Bb	Bb	Bb
OLC	papier	papier	papier	Bb	Bb	Bb	Bb
OKC: notulen	Bb	Bb	Bb	Bb	Bb	Bb	Bb
OKC: rapporten	Bb	Bb	Bb	Bb	Bb	Bb	Bb
Curriculumcommissie	n.v.t.	n.v.t.	n.v.t.	n.v.t.	papier	papier	papier
Teamoverleggen					papier	papier	papier

In addition, the following documents were available (in Dutch):

- Osiris course catalogue (digital);
- Boekje 1e 100 afgestudeerden BME (omschrijving opdrachten en huidig werkveld);
- Kwartielhandleidingen nieuw curriculum 1 t/m 4 collegejaar 2011-2012;
- Onderwijsinformatie Kwartiel 4 2011-2012 nieuw curriculum (kwartielhandleiding K4, toetsmatrijs/voorbeeld toets Mechanica en aantal uitgewerkte tentamens v. studenten;
- 1 exemplaar van alle studieboeken Bachelor BMT en Master BME;
- Brochures Bachelor BMT en Master BME opleiding periode 2006 tot en met heden;
- Documentatie vakken Bachelor en Master (selectie van representatieve voorbeelden van tentamens (bij schriftelijke tentamens, cijfers, berekening cijfer), vakbeschrijvingen, toetsmatrijs van de volgende vakken:

Vaknaam	Vakcode	Jaar
BMPO Biomechanica	192711020	Bachelor 1
Inleiding Wiskunde I	191511911	Bachelor 1
Inleiding Wiskunde II	191511921	Bachelor 1
MAM Optica	191402090	Bachelor 1
Adapterende botten	201100227	Bachelor 1
Inleiding Geneeskunde	192703000	Bachelor 2
Thermodynamica en Fysische Chemie	191350055	Bachelor 2
Zorg- en Revalidatietechnologie	192730550	Bachelor 2
Mechanica van technische en biologische materialen	191150300	Bachelor 3
Home Care Technology	191211470	Master HFT-Care
Human Movement Control	191150480	Master HFT
Mathematical Modelling II	191505270	Master HFT-BPh
Mobile E-health application and services	192631000	Master HFT-Care
Non-invasive Diagnostics	193542040	Master HFT, MCTE
Technology for the Support of Human Functions	191211310	Master HFT (alle)

Appendix 8: Declarations of independence

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DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: Jos Vander Sloten

HOME ADDRESS: Langestraat 62
3190 Boortmeerbeek
Belgium

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS AN EXPERT / SECRETARY:

BSc & MSc TU Twente

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION:

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

1

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HEREBY CERTIFIES TO NOT HAVING MAINTAINED SUCH CONNECTIONS OR TIES WITH THE INSTITUTION DURING THE PAST FIVE YEARS;

CERTIFIES TO OBSERVING STRICT CONFIDENTIALITY WITH REGARD TO ALL THAT HAS COME AND WILL COME TO HIS/HER NOTICE IN CONNECTION WITH THE ASSESSMENT, INSOFAR AS SUCH CONFIDENTIALITY CAN REASONABLY BE CLAIMED BY THE PROGRAMME, THE INSTITUTION OR NVAO;

HEREBY CERTIFIES TO BEING ACQUAINTED WITH THE NVAO CODE OF CONDUCT.

PLACE: Boortmeerbeek DATE: 11/9/12

SIGNATURE:

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W309

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DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: Johannes J. Struijk

HOME ADDRESS: Aalborgvej 11
9575 Terndrup
Denmark

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS AN EXPERT / SECRETARY:

Biomedical Technology B.Sc.
Biomedical Engineering M.Sc.

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION:

University of Twente

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

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HEREBY CERTIFIES TO NOT HAVING MAINTAINED SUCH CONNECTIONS OR TIES WITH THE INSTITUTION DURING THE PAST FIVE YEARS;

CERTIFIES TO OBSERVING STRICT CONFIDENTIALITY WITH REGARD TO ALL THAT HAS COME AND WILL COME TO HIS/HER NOTICE IN CONNECTION WITH THE ASSESSMENT, INSOFAR AS SUCH CONFIDENTIALITY CAN REASONABLY BE CLAIMED BY THE PROGRAMME, THE INSTITUTION OR NVAO;

HEREBY CERTIFIES TO BEING ACQUAINTED WITH THE NVAO CODE OF CONDUCT.

PLACE: Aalborg DATE: 10 sept. 2012

SIGNATURE:

2

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nederlands - vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: Jos A E Spaan

PRIVÉ ADRES:

C. Boyerstraat 10

1325 LH Almere.

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Biomedical Engineering,

AANGEVRAAGD DOOR DE INSTELLING:

TUE

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

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VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Eindhoven DATUM: okt 9 2012

HANDTEKENING:

2

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DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: Richard Reilly

Office ~~HOME~~ ADDRESS: Trinity College Dublin, Dublin 2, Ireland

home address 10 Nutley Road
Ballsbridge
Dublin 4, Ireland

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS AN EXPERT / SECRETARY:

University of Twente BSc and MSc Biomedical Engineering

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION:

University of Twente.

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

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HEREBY CERTIFIES TO NOT HAVING MAINTAINED SUCH CONNECTIONS OR TIES WITH THE INSTITUTION DURING THE PAST FIVE YEARS;

CERTIFIES TO OBSERVING STRICT CONFIDENTIALITY WITH REGARD TO ALL THAT HAS COME AND WILL COME TO HIS/HER NOTICE IN CONNECTION WITH THE ASSESSMENT, INSOFAR AS SUCH CONFIDENTIALITY CAN REASONABLY BE CLAIMED BY THE PROGRAMME, THE INSTITUTION OR NVAO;

HEREBY CERTIFIES TO BEING ACQUAINTED WITH THE NVAO CODE OF CONDUCT.

PLACE: University of Twente DATE: 13/3/2012

SIGNATURE:

2

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ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: S. van Tienhoven (Sandra)

PRIVÉ ADRES: Hoogstraat 426
5654 NK Eindhoven

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Biomedische Technologie (Bachelor)
Biomedical Engineering (Master)

AANGEVRAAGD DOOR DE INSTELLING:

Rijksuniversiteit Groningen
Universiteit Twente

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

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VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Eindhoven

DATUM: 11-5-2012

HANDTEKENING:

2

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DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: Linda van der Grijspaarde

HOME ADDRESS:

Opwierderweg 150
Appingedam

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS ~~AN EXPERT~~ / SECRETARY:

Biomedical Engineering

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION:

Universiteit Twente, TU Delft, TU/e

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

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HEREBY CERTIFIES TO NOT HAVING MAINTAINED SUCH CONNECTIONS OR TIES WITH THE INSTITUTION DURING THE PAST FIVE YEARS;

CERTIFIES TO OBSERVING STRICT CONFIDENTIALITY WITH REGARD TO ALL THAT HAS COME AND WILL COME TO HIS/HER NOTICE IN CONNECTION WITH THE ASSESSMENT, INSOFAR AS SUCH CONFIDENTIALITY CAN REASONABLY BE CLAIMED BY THE PROGRAMME, THE INSTITUTION OR NVAO;

HEREBY CERTIFIES TO BEING ACQUAINTED WITH THE NVAO CODE OF CONDUCT.

PLACE: Appingedam

DATE: 21 november 2012

SIGNATURE:

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