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PEER REVIEW NEW PROGRAMME

ACADEMIC BACHELOR
CIRCULAR ENGINEERING
Maastricht University

SUMMARY REPORT
16 November 2020

1 Peer Review

The quality of a new programme is assessed by means of peer review. A panel of independent peers including a student reviews the plans during a site visit to the institution. A discussion amongst peer experts forms the basis for the panel's final judgement and the advisory report. The focus is on the curriculum, the teaching and learning environment, and student assessment.

The Accreditation Organisation of the Netherlands and Flanders (NVAO) takes a formal decision on the quality of the new programme based on the outcome of the peer review. This decision can be positive, conditionally positive or negative. Following a positive NVAO decision with or without conditions the institution can proceed to offer the new programme. Upon completion of the programme, graduates are entitled to receive a legally accredited degree.

This summary report contains the main outcomes of the peer review. A full report with more details including the panel's findings and analysis is also available. NVAO bases an accreditation decision on the full report.

Both the full and summary reports of peer reviews are published on NVAO's website www.nvao.net. There you can also find more information on NVAO and peer reviews of new programmes.

Because of COVID-19 temporary measures apply for this peer review.

2 Panel

Peer experts

1. Em. Prof. dr. ir. J.C. (Han) Brezet (*chair*), professor of Sustainable Product Innovation, University of Aalborg, Denmark; emeritus professor Design for Sustainability, Delft University of Technology, the Netherlands;
2. Prof. dr. J. (Jarka) Glassey, professor of Chemical Engineering Education, School of Engineering, Newcastle University, United Kingdom;
3. Prof. Dr.-Ing. Th. (Theodor) Doll, professor of Biomaterial Engineering, Hannover Medical School, Germany;
4. W. (Willem) Gommans BSc (*student*), master student Construction Management and Engineering, Eindhoven University of Technology, the Netherlands.

Assisting staff

- Dr. M.J.H. (Marianne) van der Weiden, secretary;
- M. (Michèle) Wera MA, NVAO policy advisor and process coordinator.

Site visit (online)
16 October 2020

3 Outcome

The NVAO approved panel reaches a conditionally positive conclusion regarding the quality of the academic bachelor Circular Engineering offered by Maastricht University. This three-year full-time programme (180 EC) offers a solid interdisciplinary basis in chemical engineering, biotechnology and engineering physics and a specialization in one of these three disciplines. The programme is offered in Maastricht and on innovation campuses in the region.

Maastricht University offers an ambitious and interdisciplinary new programme in circular engineering at academic bachelor's level. Its graduates will contribute to a circular and sustainable economy after completing this programme. In the first year, students gain fundamental knowledge and skills in chemical engineering, biotechnology and engineering physics, before they choose one of these three disciplines as a concentration in the third year. In the second year, students select courses from a wide range of electives, guided by an academic advisor. The panel wishes more assurances that all these courses contribute to the programme's learning objectives.

The student-centered approach and the link with the professional field are strong points: students work together in small tutorial groups and increase their knowledge by working on theoretical and research problems of increasing complexity. International students will enhance the diversity of the groups and thus provide useful professional competencies for graduates practising in globalised economies. The interdisciplinary problem-solving approach fits the needs of the professional field. At the end of the programme, students write a thesis on a research and design project. Most projects will be performed at one of the Brightlands campuses. This is where the university collaborates with commercial and public partners, such as the Brightlands campuses, on innovations in different fields, including sustainability. The quality of the programme is good: courses are of bachelor level and aligned with the research activities of staff. The teaching staff is motivated and experienced. The programme has a clear framework for assessment and makes use of an appropriate range of assessment methods. The Board of Examiners plays an active role in ensuring the quality of assessments.

The panel is, therefore, convinced of the quality of the proposed programme BSc Circular Engineering and expects that, if the role of the electives in year 2 is clarified and guaranteed, the BSc Circular Engineering will be an innovative and attractive programme. All in all, the panel assesses the quality of the programme as conditionally positive.

4 Commendations

The programme is commended for the following features of good practice.

1. Market demand – The professional field is strongly involved in the programme. Large and small companies at the triple-helix Brightlands campuses emphasize the need for circular engineers.

2. Interdisciplinarity – Students learn to address problems of sustainability from multiple disciplinary viewpoints.

3. Learning methods – The problem-based and research-based learning approach stimulates students to actively develop new knowledge and skills. Working in small tutorial groups contributes to students' (inter)personal skills and teaches them to take different backgrounds and viewpoints into consideration.

4. Teaching team – The teaching staff is enthusiastic, well-qualified and knowledgeable in their respective areas. They are active researchers and able to bring in the latest developments in their field. As a team, they provide a solid basis for the new programme in Circular Engineering.

5 Recommendations

For further improvement to the programme, the panel recommends a number of follow-up actions.

1. Circular engineering practice – Make sure to include circular engineering practice more explicitly in the learning objectives.

2. Complexity of courses – Review the complexity of the material offered in the third-year courses. Some science and engineering courses are very detailed and of an almost master's level, while others lack detail on circular engineering aspects.

3. Individual assessment – Maintain continuous vigilance when assessing the individual contribution in group work and peer evaluations.

6 What comes next?

NVAO grants initial accreditation to a new programme on the basis of a panel's full report. The decision is valid for a maximum of six years. Upon accreditation, the new programme will follow the NVAO review procedures for existing programmes. NVAO publishes the accreditation decision together with the full report. A full report is also available.[1]

Each institution has a system of quality assurance in place ensuring continuous follow-up actions and periodic peer-review activities. Peer reviews help the institution to improve the quality of its programmes. The progress made since the last review is therefore taken into consideration when preparing for the next review. The follow-up activities are also part of the following peer-review report. For more information, visit the institution's website.[2]

[1] https://www.nvao.net/nl/besluiten
[2] https://www.maastrichtuniversity.nl/

7 Summary in Dutch

Het panel oordeelt positief onder voorwaarden over de kwaliteit van de wo-bacheloropleiding Circular Engineering van de Universiteit Maastricht. Dit is de uitkomst van de kwaliteitstoets uitgevoerd door een panel van *peers* op verzoek van de Nederlands-Vlaamse Accreditatieorganisatie (NVAO). Voor deze beoordeling heeft het panel online gesprekken gevoerd met de opleiding op 16 oktober 2020.

Met de bacheloropleiding Circular Engineering wil de Universiteit Maastricht ingenieurs opleiden die kunnen bijdragen aan een circulaire en duurzame economie. Het betreft een voltijds programma van drie jaar. Het curriculum is interdisciplinair: in het eerste jaar krijgen studenten basiskennis en -vaardigheden in chemische technologie, biotechnologie en technische natuurkunde, voordat ze in het derde jaar een van deze drie disciplines als uitstroomprofiel kiezen. In het tweede jaar kiezen studenten cursussen uit een breed aanbod, daarbij geadviseerd door een academisch staflid. Het panel vindt het noodzakelijk dat de opleiding aantoont op welke wijze al deze cursussen bijdragen aan de leerdoelen van de opleiding.

De studentgerichte aanpak en de sterke verbinding met het bedrijfsleven zijn sterke punten: studenten leren door in tutorgroepen te werken aan theoretische en onderzoeksproblemen die steeds complexer worden. Internationale studenten zullen bijdragen aan de diversiteit van de tutorgroepen en leiden tot bredere inzichten. De interdisciplinaire en probleemgerichte aanpak past bij de behoeften van het werkveld. Aan het eind van de opleiding schrijven de studenten een scriptie op basis van een onderzoeksproject dat in veel gevallen zal worden uitgevoerd op een van de Brightlands campussen. Daar werkt de universiteit samen met commerciële en publieke partners aan maatschappelijk relevante thema's, waarbij duurzaamheid centraal staat. De kwaliteit van de opleiding is goed: het niveau van de cursussen past bij een academische bacheloropleiding. De docenten zijn enthousiast en capabel. De examens en opdrachten zijn gevarieerd en passen bij de leerdoelen. De examencommissie ziet adequaat toe op de kwaliteit van de toetsing.

Het panel is daarom overtuigd van de kwaliteit van de beoogde bacheloropleiding Circular Engineering en verwacht dat dit, als de rol van de keuzecursussen in jaar 2 verduidelijkt en gegarandeerd is, een innovatief en aantrekkelijk programma zal zijn. Concluderend beoordeelt het panel de opleiding als voorwaardelijk positief.

Meer informatie over de NVAO-werkwijze en de toetsing van nieuwe opleidingen is te vinden op www.nvao.net. Voor informatie over de Universiteit Maastricht verwijzen we naar de website van de instelling.[3]

Als gevolg van de beperkende omstandigheden door COVID-19 geldt voor deze kwaliteitstoets een tijdelijke en versnelde procedure.

[3] https://www.maastrichtuniversity.nl/nl

The summary report was written at the request of NVAO and is the outcome of the peer review of the new programme academic bachelor Circular Engineering of Maastricht University

Application no: 009198

NVAO

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INITIAL ACCREDITATION

ACADEMIC BACHELOR
CIRCULAR ENGINEERING
Maastricht University

FULL REPORT
16 November 2020

Content

1 Peer review

The Accreditation Organisation of the Netherlands and Flanders (NVAO) determines the quality of a new programme on the basis of a peer review. This initial accreditation procedure is required when an institution wishes to award a recognised degree after the successful completion of a study programme.

The procedure for new programmes differs slightly from the approach to existing programmes that have already been accredited. Initial accreditation is in fact an ex ante assessment of a programme. Once accredited the new programme becomes subject to the regular review process.

The quality of a new programme is assessed by means of peer review. A panel of independent peers including a student reviews the plans during a site visit to the institution. A discussion amongst peer experts forms the basis for the panel's final judgement and the advisory report. The agenda for the panel visit and the documents reviewed are available from the NVAO office upon request.

The outcome of this peer review is based on the standards described and published in the limited NVAO Assessment framework for the higher education accreditation system of the Netherlands (Stcrt. 2019, nr. 3198). Each standard is judged on a three-point scale: meets, does not meet or partially meets the standard. The panel will reach a conclusion about the quality of the programme, also on a three-point scale: positive, conditionally positive or negative.

This report contains the findings, analysis and judgements of the panel resulting from the peer review. It also details the commendations as well as recommendations for follow-up actions. A summary report with the main outcomes of the peer review is also available.

NVAO takes an accreditation decision on the basis of the full report. The NVAO decision can be positive, conditionally positive or negative. Following a positive NVAO decision with or without conditions the institution can proceed to offer the new programme.

Both the full and summary reports of each peer review are published on NVAO's website www.nvao.net. There you can also find more information on NVAO and peer reviews of new programmes.

Because of COVID-19 temporary measures apply for this peer review.

2 New programme

2.1 General data

Institution	: Maastricht University
Programme	: academic bachelor[1] Circular Engineering
Mode of study	: fulltime
Degree	: Bachelor of Science
Concentrations	: Circular Chemical Engineering; Sustainable Biotechnology; Engineering Physics for Sustainable Manufacturing
Location	: Maastricht
Study load	: 180 EC[2]
Field of study	: Technology (CROHO sector Techniek) (confirmed by the panel)

2.2 Profile

With the BSc Circular Engineering, Maastricht University intends to meet the demand for graduates with a solid background in chemical engineering, biotechnology and/or engineering physics, who are able to look across existing boundaries and to connect different disciplines and stakeholders in offering technical solutions that aid the transition towards a circular economy. Students will acquire knowledge and skills in engineering, mathematics and natural sciences, with emphasis on circularity and sustainability. Parts of the programme will be organized in collaboration with commercial and public partners at the Brightlands campuses in the Province of Limburg.

2.3 Panel

Peer experts

1. Em. Prof. dr. ir. J.C. (Han) Brezet (*chair*), professor of Sustainable Product Innovation, University of Aalborg, Denmark; emeritus professor Design for Sustainability, Delft University of Technology, the Netherlands;
2. Prof. dr. J. (Jarka) Glassey, professor of Chemical Engineering Education, School of Engineering, Newcastle University, United Kingdom;
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Assisting staff

– Dr. M.J.H. (Marianne) van der Weiden, secretary;
– M. (Michèle) Wera MA, NVAO policy advisor and process coordinator.

Site visit (online)
16 October 2020

[1] In Dutch: wo-bachelor
[2] European Credits

3 Outcome

The NVAO approved panel reaches a conditionally positive conclusion regarding the quality of the wo-bachelor Circular Engineering offered by Maastricht University. The programme complies with standards 1 and 3 of the limited NVAO framework and partially complies with standard 2.

Maastricht University offers an ambitious and interdisciplinary new programme in circular engineering at academic bachelor's level. Its graduates will contribute to a circular and sustainable economy after completing this three-year fulltime programme. In the first year, students gain fundamental knowledge and skills in chemical engineering, biotechnology and engineering physics, before they choose one of these three disciplines as a concentration in the third year. In the second year, students select courses from a wide range of electives, guided by an academic advisor. The panel wishes more assurances that all these courses contribute to the programme's learning objectives.

The student-centered approach and the link with the professional field are strong points: students work together in small tutorial groups and increase their knowledge by working on theoretical and research problems of increasing complexity. International students will enhance the diversity of the groups and thus provide useful professional competencies for graduates practising in globalised economies. The interdisciplinary problem-solving approach fits the needs of the professional field. At the end of the programme, students write a thesis on a research and design project. Most projects will be performed at one of the Brightlands campuses. This is where the university collaborates with commercial and public partners, such as the Brightlands campuses, on innovations in different fields, including sustainability. The quality of the programme is good: courses are of bachelor level and aligned with the research activities of staff. The teaching staff is motivated and experienced. The programme has a clear framework for assessment and makes use of an appropriate range of assessment methods. The Board of Examiners plays an active role in ensuring the quality of assessments.

The panel is, therefore, convinced of the quality of the proposed programme BSc Circular Engineering and expects that, if the role of the electives in year 2 is clarified and guaranteed, the BSc Circular Engineering will be an innovative and attractive programme. All in all, the panel assesses the quality of the programme as conditionally positive.

The condition to be met within a period of two years is the following:

- Ensure the relevance of students' study paths in year 2 by making an explicit link between each elective course, circular engineering and the programme's intended learning outcomes, evidenced in the course descriptions, their learning goals and assessment.

Standard	Judgement
1 Intended learning outcomes	meets the standard
2 Teaching-learning environment	partially meets the standard
3 Student assessment	meets the standard
Conclusion	**conditionally positive**

4 Commendations

The programme is commended for the following features of good practice.

1. Market demand – The professional field is strongly involved in the programme. Large and small companies at the triple-helix Brightlands campuses emphasize the need for circular engineers.

2. Interdisciplinarity – Students learn to address problems of sustainability from multiple disciplinary viewpoints.

3. Learning methods – The problem-based and research-based learning approach stimulates students to actively develop new knowledge and skills. Working in small tutorial groups contributes to students' (inter)personal skills and teaches them to take different backgrounds and viewpoints into consideration.

4. Teaching team – The teaching staff is enthusiastic, well-qualified and knowledgeable in their respective areas. They are active researchers and able to bring in the latest developments in their field. As a team, they provide a solid basis for the new programme in Circular Engineering.

5 Recommendations

For further improvement to the programme, the panel recommends a number of follow-up actions.

1. Circular engineering practice – Make sure to include circular engineering practice more explicitly in the learning objectives.

2. Complexity of courses – Review the complexity of the material offered in the third-year courses. Some science and engineering courses are very detailed and of an almost master's level, while others lack detail on circular engineering aspects.

3. Individual assessment – Maintain continuous vigilance when assessing the individual contribution in group work and peer evaluations.

6 Assessment

6.1 Standard 1: Intended learning outcomes

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

Judgement
Meets the standard.

Findings, analysis and considerations
With the BSc Circular Engineering, Maastricht University (UM) aims to be part of the transition to a circular economy by educating engineers who are specialists in the field of sustainability. The initiative ties in with UM's ambition in the STEM (Science, Technology, Engineering and Mathematics) domain over the past years and contributes to its aims of inclusion, innovation and sustainability. Circular engineers will have the knowledge, understanding and skills required to respond to technical complexities and apply the concepts of remake, reuse, repair and recycle to facilitate and accelerate circularity, integrating technical solutions with the broader environmental and societal context. Chemical engineering, biotechnology and engineering physics will be their background because these disciplines provide the driving forces in the successful transition to a circular economy. The panel considers this ambition to be in line with current trends. The programme will, therefore, definitely answer an economic and societal need.

Suitable intended learning outcomes have been formulated in line with this ambition. Graduates will have a solid background in chemical engineering, biotechnology and/or engineering physics, combined and integrated with mathematics and natural sciences and with an emphasis on circularity and sustainability. They will be able to look across existing boundaries and connect different disciplines and stakeholders. This is formulated in a comprehensive set of intended learning outcomes. Graduates will have:

1. breadth of academic and engineering knowledge;
2. in-depth academic and engineering expertise in the field of circular engineering;
3. a scientific and intellectual attitude;
4. in-depth insights into the societal and environmental contexts in which they perform;
5. highly-developed (inter)personal skills.

The panel is satisfied that the intended learning outcomes are in line with the Dublin descriptors at bachelor level and other national and international scientific and professional engineering standards (ABET, CDIO and the Dutch 'Criteria for Academic Bachelor's and Master's Curricula' of the 4TU Federation). The panel also recognizes that the intended learning outcomes of courses, skills training courses, projects and the bachelor thesis are derived from the intended learning outcomes at the programme level. Students will learn the fundamentals of the three disciplines chemical engineering, biotechnology and engineering physics and have practical project experience in all three before they choose a concentration in the third year: Circular Chemical Engineering, Sustainable Biotechnology or Engineering Physics for Sustainable Manufacturing. At first glance, the panel missed the focus on circular engineering in the intended learning outcomes. The sciences are well represented, but the circularity and engineering fundamentals are less clear in the programme's objectives. The panel's concern was alleviated in the discussions with teaching staff, who could explain

satisfactorily how these aspects are covered at course level. The panel suggests making circular engineering practice more explicit in the intended learning outcomes.

The programme will be partly offered at the 'triple-helix' Brightlands campuses in Maastricht (medical technology and physical instrumentation), Heerlen (computer science and data sciences), Geleen (circular chemistry) and Venlo (biotechnology and food science), where the university collaborates in research with commercial and public partners. Each campus has its own thematic focus, but sustainability is an important theme in all of them. During the site visit, the panel met a number of representatives from the professional field. Some of them were associated with international companies located at one of the Brightlands campuses, but smaller companies (SME, start-up) were represented as well. The discussion clearly showed that the proposed bachelor programme provides what the professional field needs: the combination of breadth of knowledge and proof that a student can go in-depth, as well as a basis for further learning and specialization. The representatives from the professional field emphasized that an interdisciplinary approach is necessary to bridge the different disciplinary areas in order to find solutions and expect that the circular engineering programme will offer this. The panel is impressed with the programme's interaction with industry and encourages the team to maintain that and perhaps formalize it to keep the programme up to date and relevant.

Summing up, the panel considers the programme to be a convincing response to the needs of society and industry, fitting in with major themes of UM. Students will receive an ambitious and interdisciplinary education in circular engineering at academic bachelor's level, which is expressed in a list of appropriate intended learning outcomes.

6.2 Standard 2: Teaching-learning environment

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

Judgement
Partially meets the standard.

Findings, analysis and considerations
The BSc Circular Engineering is a full-time programme of 180 EC, divided into six semesters, each consisting of three periods of 8-8-4 weeks. The 8-week periods are devoted to theoretical courses and skills training courses, while projects are organized in the 4-week periods. Year 1 consists of eight compulsory courses and four skills training courses, covering a broad range of engineering domains. They create a theoretical and practical foundation for the three concentrations of the programme: Circular Chemical Engineering; Sustainable Biotechnology; Engineering Physics for Sustainable Manufacturing. Year 2 gives students the freedom to set their individual trajectory in choosing two courses and one skills training per period. Each semester concludes with a project. Year 3 is divided into two parts. The first part offers deepening of knowledge and expertise in one of the three concentrations: five mandatory courses and two mandatory skills training courses. The second part consists of the bachelor thesis and a mandatory course in Ethical and Philosophical Reflections. The panel is satisfied with the clear curriculum outline; the curriculum content is broad and suitable for the interdisciplinary approach of the programme. It also considers the three concentrations a sensible choice, aligning with the university's strengths.

In preparation of the site visit, the panel received more detailed course descriptions of the first and third-year courses, the projects and the bachelor thesis. On its request, the panel was also provided with an overview of each course's function in the programme and how they build on each other (structural alignment), an overview of recommended courses per concentration and a list of possible thesis topics. The available course descriptions are clear and comprehensive. The panel understands that time is limited and the programme's focus is on engineering, but recommends considering if the elective course on Circular Business Development should be offered to all students as a fundamental (mandatory) course. In due course, extending the programme content with process engineering basics, mechanical engineering basics and ecosystems could be considered.

The panel asked for the additional information, partly because it wondered if, with the large choice of electives in year 2, the programme could ensure the attainment of the learning objectives by all students. During the site visit, the programme staff explained that, in year 2, all students will build up a framework in engineering, necessary for the concentrations in year 3. The courses have different flavours, but the learning objectives are the same. The teachers emphasized that students are intensively guided in their selection of courses. Experiences in UM programmes with a similar design are positive and show that this approach strengthens the students' motivation. The panel appreciated learning that the elective courses will be organized specifically for circular engineering students and that, even if a similar course is offered in another programme, questions and exercises will be tailored to the themes of circularity and systems thinking. Despite these reassurances, the panel is not quite satisfied with the set-up of year 2 and its large degree of freedom. To ensure that a student's choice will not compromise the necessary preparation for their chosen concentration and the achievement of the intended learning outcomes, the panel considers it necessary for the programme to make an explicit link between each elective course, circular engineering and the programme's intended learning outcomes, evidenced in the course descriptions, their learning goals and assessment.

The panel advises having a closer look at the content of some of the courses of year 3, since their level is at times variable. For example, in the concentration Sustainable Biotechnology, the course on Plant Biotechnology contains a lot of complex material more suited for a specialist master's degree (and raises questions why plant expression systems are prioritized over the industrially more utilized microbial or cell culture systems, engineering aspects of which should be provided as a background to biotech students), yet the course on Bioreactors contains very little detail on important (circular) engineering aspects of 'residual' raw material processing, scale-up, etc. The academic team may wish to review the complexity of the material offered in the third-year courses.

Education in the bachelor Circular Engineering is built on the principles of Problem-Based Learning (PBL). Students work in small tutorial groups of less than fifteen students and engage in interaction with each other and the academic staff. The application file describes PBL as a constructive, collaborative, contextual and self-directed learning approach, leading to better problem-solving and interpersonal skills. In addition to PBL, the programme will employ Research-Based Learning (RBL). Along similar lines as in PBL, students are confronted with increasingly complex problems and develop the skills to do research and to design solutions to existing and future challenges, with special attention to the engineering design cycle. The panel feels that the principles of PBL and RBL to be used in the programme delivery are commendable, as is the use of projects and teamwork throughout the

programme. These are useful didactic approaches for an interdisciplinary engineering programme.

Because the orientation and focus of the programme are international and directed at students who can develop innovative, technical solutions to the worldwide challenges in the transition to a circular economy, the language of instruction is English. The academic and engineering communities are internationally oriented, the teaching staff are interdisciplinary and international and the stakeholders in the industry are globally active companies. The panel, therefore, agrees that using English as the language of instruction will enhance the students' chances on both the national and international labour markets. It also makes it possible to admit an internationally diverse student group and create an international classroom. The language requirements for teaching staff and students and the support offered to non-native speakers are appropriate.

Admission procedures and criteria are clearly presented in the application file. Students can be admitted to the programme if they have achieved a sufficient level of mathematics, physics and biology and/or chemistry in their secondary education. Since the programme is taught in English, they must also submit proof of sufficient English proficiency. The panel supports the programme's wish for a diverse and international student group and agrees that the different perspectives and backgrounds will enhance the learning experience in the PBL and RBL tutorial groups.

At the start of the programme, every student is assigned an academic staff member as an advisor. These advisors guide students throughout the programme by helping them to select electives and a concentration, based on the student's personal goals and ambitions. The academic advisors thus contribute to the coherence of the curriculum for each student. Student and academic advisor meet at least twice a year, but more often if a student needs more advice or guidance, e.g. to address study delay or non-study related issues. The panel considers it an asset that academic guidance is available to help students make the right choices in their curriculum.

The teaching staff consists of the Programme Director, the coordinators of the three concentrations and dedicated academic staff members. Staff members cover different disciplines and are active in a diverse range of research groups in engineering, mathematics and natural sciences. Teaching staff is systematically trained in their teaching and assessment skills through the University Teaching Qualification (UTQ). This includes learning how to create the active learning environment of the PBL approach. The content of the BSc Circular Engineering is aligned with the research themes of the Faculty of Science and Engineering. In addition, various knowledge centers (Brightsite on chemical engineering, M4I on molecular imaging of materials, MERLN on regenerative medicine and IDEE on instrument development) are involved in the development of the programme. The panel appreciates that, in this research context, students can be taught the latest developments. The panel met a number of staff members during the site visit and found them enthusiastic, well-qualified and knowledgeable in their respective areas. The teaching team is, therefore, a good basis for the programme.

Because of the online procedure, the panel did not visit any of the facilities. The university's website and the application file, however, provided ample information. The fact that the

programme will be partly offered at the 'triple-helix' Brightlands campuses is a strong point and will enable the students to work on actual problems of circular engineering.

Summing up, the panel recognizes a number of strong points in the proposed bachelor programme: the didactical approach of PBL and RBL, the quality and dedication of the teaching staff, the research context and the collaboration with the Brightlands campuses. The panel is convinced that year 1 of the curriculum will provide the students with a strong basis. For year 2, the panel wishes to see more assurances that each of the electives will provide the right preparation for the concentrations and contribute to circular engineering and the programme's intended learning outcomes, regardless of a student's choice. The panel advises to check the level of complexity of the courses in year 3, because this seems to vary. The panel expects that, if the role of the electives in year 2 is clarified and guaranteed, the BSc Circular Engineering will be an innovative and attractive programme.

6.3 Standard 3: Student assessment

The programme has an adequate system of student assessment in place.

Judgement
Meets the standard.

Findings, analysis and considerations
The panel notes that the BSc Circular Engineering follows the UM and Faculty of Science and Engineering assessment policy, which is thorough and well-considered. Assessment is considered an integral part of education: a tool to develop and test knowledge and to support and enhance learning. Four elements form the backbone of the vision on assessment. Firstly, constructive alignment of the intended learning outcomes, both at programme level (visualized in an assessment programme) and at course level. Course coordinators design an assessment plan, based on the requirements that assessments are authentic and relevant, embedded in teaching and learning activities, a balanced mix of formative and summative assessments, and focused on the ability to use and apply the range of knowledge, understanding and skills. Secondly, assessment is not only used to determine whether a student has mastered the course objectives (assessment of learning), but also to enhance a student's learning by providing feedback (assessment for learning). Further, assessment and instructional design are aligned in terms of content, form and cognitive complexity (assessment as learning). Thirdly, assessment is continuously adjusted on the basis of evaluations and developments in the discipline. Fourthly, student engagement is stimulated by using self and peer assessment, organizing inspection hours for exams, providing appropriate feedback forms and clear rubrics and collecting student feedback through evaluations.

Different assessment methods are used, as could be verified from the course descriptions. Typical assessment methods for courses are individual written exams, computer-based exams, reports and papers. Assessment of skills training and projects is both at the individual and team level. This includes self-evaluation, peer evaluation, input from academic staff members and/or company representatives. The latter is done on the basis of rubrics to ensure equal treatment of all students and alignment with the intended learning outcomes. Based on the discussion with teaching staff and the Board of Examiners (BoE), the panel is comfortable with the way peer evaluation is organized, avoiding that they evaluate each other either too positively or too harshly. The panel learned that staff members have gained

experience with this method in other teaching programmes. Nevertheless, the panel advises continuous vigilance on the part of the teaching staff in peer evaluations and when assessing the individual contribution in groupwork.

The assessment of the bachelor thesis consists of four components: proposal, practical work, thesis and presentation/defence. Each component is assessed independently by the thesis supervisor and the internal thesis advisor. The supervisor assists the student in defining the thesis topic and oversees the research and design process, the internal thesis advisor monitors the thesis process and the academic quality. At programme level, the thesis coordinator is responsible for the overall quality of the theses and ensures consistency of feedback and grading. The thesis coordinator evaluates and processes the grades and feedback provided by the thesis supervisor and internal thesis advisor. In this way, three staff members are involved, which secures the reliability of the grades. The use of standardized rubrics contributes to the validity of the assessment. The panel is assured of the solidity of this process, but notes that possible thesis topics, sent to the panel in preparation of the site visit, seem to lean more to science than to engineering. The panel encourages the BoE to monitor this.

The validity, reliability and transparency of assessment are ensured by the use of the course assessment plans. These are evaluated by the Programme Director for constructive alignment purposes and by the BoE from a quality assurance point of view. Within a course, grading rubrics and multiple moments of feedback safeguard reliability. Transparency is achieved by full information on assessment in the course manuals. Teaching staff is trained in assessment through the UTQ programme and further professionalization programmes. Expert advice and written resources are available for further support. The panel considers this a satisfactory set of measures to guarantee the quality of assessment.

The BSc Circular Engineering has its own BoE. Representatives of this Board informed the panel that they have been involved from the inception of the programme. They were able to give their advice, based on the members' experience in other programmes with an open curriculum. The BoE members explained that they monitor the quality of assessment and the final level of the degree by checking assessment plans and thesis plans. The panel discussed the risk that the academic quality of projects is compromised by conditions set by a company. The BoE explained that this is avoided by clear agreements at the start of a project. They also emphasized that the study programme is in the lead since it concerns a learning experience and that companies are aware of this. The panel is convinced that the BoE is up to its task and appreciates that it has been involved from the beginning.

The panel concludes that the programme has a sound and transparent system of assessment in place. It is characterised by an appropriate set of assessment forms and fits the intended learning outcomes and didactic approach of PBL and RBL. The BoE plays an important and proactive role in ensuring the quality of assessment.

6.4 Degree and field of study

The panel advises awarding the following degree to the new programme: Bachelor of Science.
The panel supports the programme's preference for the following field of study: Technology (CROHO sector Techniek).

Abbreviations

4TU	Federation of Dutch universities of technology (Delft, Eindhoven, Twente, Wageningen)
ABET	Accreditation Board for Engineering and Technology
BoE	Board of Examiners
CDIO	Conceive Design Implement Operate
EC	European Credit
NVAO	Netherlands Flanders Accreditation Organisation
PBL	Problem-Based Learning
RBL	Research-Based Learning
UM	Maastricht University
UTQ	University Teaching Qualification

The full report was written at the request of NVAO and is the outcome of the peer review of the new programme
Academic bachelor Circular Engineering of Maastricht University

Application no: 009198

NVAO

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