Assessment report
Limited Framework Programme Assessment

Bachelor Chemical Engineering and Chemistry

Eindhoven University of Technology

Contents of the report

1. Executive summary

In this executive summary, the panel presents the main considerations which led to the assessment of the quality of the Bachelor Chemical Engineering and Chemistry programme of Eindhoven University of Technology. The programme was assessed according to the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, published on 20 December 2016 (Staatscourant nr. 69458).

The programme objectives are sound. The panel welcomes the broadness of the programme, allowing students to acquire knowledge and understanding of both the chemistry and chemical engineering domains and also allowing students to continue their studies in one of these domains at master level. The panel considers this bachelor-master trajectory to be a very valuable concept. The panel understands and supports the programme position to educate students to continue their studies at master level and not so much to enter the labour market. The panel acknowledges the relevance for the programme to monitor current trends in industry. The panel advises to formulate future trends in more clear terms to allow the programme to adjust to these trends.

The objectives of the programme are within the boundaries of the domain-specific reference framework for academic chemical sciences programmes. The panel appreciates the efforts by the joint programmes in chemical sciences in the Netherlands to draft this framework and regards this to be a sound and up-to-date description of this domain. The profile of this Eindhoven University of Technology programme may be clearly distinguished within the framework.

The programme meeting international domain-specific standards in the programme domain is appreciated by the panel.

The objectives have been translated well into the intended learning outcomes of the programme, meeting the programme objectives and matching the bachelor level criteria.

The panel regards the number of incoming students in the programme to be favourable, this number being within the programme capacity limits.

The curriculum matches the intended learning outcomes of the programme. The panel appreciates the contents of the curriculum, especially noting the courses to be seriously designed and to be solid in terms of contents. The panel regards the curriculum to be research-based and to be up-to-date, new trends being incorporated. The curriculum is coherent, the Bachelor College structure being welcomed by the panel. The panel is positive about the academic and professional skills being addressed in the curriculum and encourages the programme to continue along this path.

The lecturers in the programme are experienced and well-reputed researchers and skilled teachers. They are all PhDs and they are engaged in current, relevant research, referring to their research in the lectures. Their educational capabilities are up to standard. The capacities of the lecturers are appreciated by the students.

The entry requirements and admission procedures of the programme are appropriate. The panel welcomes the elaborate information provided for prospective students on the part of the programme.

The educational concept and the study methods of the programme are adequate and varied, promoting student-activating learning. The panel is also positive about new computer-based study methods being introduced. The panel suggests to monitor the number of practical classes in the curriculum to keep this number at required levels. The students-to-staff ratio and the number of hours of face-to-face education in the programme meet the standards. The study guidance by student mentors, study coaches and the study advisor is up to standard. The panel considers the programme to be feasible, appreciating the binding study advice in the first year of 45 EC. The student success rates are appropriate in the last years.

The programme examination and assessment policies are appropriate, being in line with the university guidelines. The position and authority of the Examination Committee for the programme are adequate, this committee being in control of the examinations and assessments of the programme.

The panel approves of the examination methods adopted in the programme, noting these are consistent with the goals and the contents of the courses. The supervision processes for the Bachelor final projects are well-organised. The assessment procedures are up to standard, involving at least two examiners and being conducted using scoring forms with relevant criteria. The panel advises to add more extensive written comments to the scoring forms to substantiate the grades of the Bachelor final projects.

The measures taken to ensure the validity, reliability and transparency of examinations and assessments are adequate. The fraud and plagiarism formalities are up to standard.

The course examinations are challenging. The panel supports the grades awarded to the Bachelor final projects by the programme examiners. The panel regards these projects to be well-elaborated and well-founded.

The panel is convinced that students having completed the programme reached the intended learning outcomes and regards the programme graduates to be well prepared to continue their studies at master level in this domain. The panel is positive about the range of master programmes graduates are admitted to.

The panel which conducted the assessment of the Bachelor Chemical Engineering and Chemistry programme of Eindhoven University of Technology assesses this programme to meet the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, judging the programme to be good. Therefore, the panel recommends NVAO to accredit this programme.

Rotterdam, 6 February 2019

Prof. dr. M.A. Cohen Stuart
(panel chair)

drs. W. Vercouteren
(panel secretary)

2. Assessment process

The evaluation agency Certiked VBI received the request by Eindhoven University of Technology to support the limited framework programme assessment process for the Bachelor Chemical Engineering and Chemistry programme of this University. The objective of the programme assessment process was to assess whether the programme would conform to the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, published on 20 December 2016 (Staatscourant nr. 69458).

Management of the programmes in the assessment cluster WO Scheikunde convened to discuss the composition of the assessment panel and to draft the list of candidates.

Having conferred with management of the Bachelor Chemical Engineering and Chemistry programme of Eindhoven University of Technology, Certiked invited candidate panel members to sit on the assessment panel. The panel members agreed to do so. The panel composition was as follows:

- Prof. dr. M.A. Cohen Stuart, professor emeritus, chair of Physical Chemistry & Colloid Chemistry, Wageningen University, professor emeritus of Physical Surface Chemistry, University of Twente, professor East China University of Science and Technology, Shanghai, China (panel chair);
- Prof. dr. A.H.T. Boyen, associate professor emeritus, Faculty of Sciences and Bio-engineering Sciences, Faculty of Medicine and Pharmacy, Vrije Universiteit Brussel (panel member);
- Prof. dr. M.K. Van Bael, professor Inorganic and Physical Chemistry, head of Inorganic and Physical Chemistry Research Group, University of Hasselt (panel member);
- Prof. dr. ir. G.B. Marin, professor Chemical Reaction Engineering, head Laboratory for Chemical Technology, Ghent University (panel member);
- Drs. O. de Vreede, head Innovation and Human Capital, VNCI, Association of the Dutch Chemical Industry (panel member);
- L. Büller BSc, student Master Life Science and Technology, Delft University of Technology (student member).

On behalf of Certiked, drs. W. Vercouteren served as the process coordinator and secretary in the assessment process.

All panel members and the secretary confirmed in writing being impartial with regard to the programme to be assessed and observing the rules of confidentiality. Having obtained the authorisation by the University, Certiked requested the approval of NVAO of the proposed panel to conduct the assessment. NVAO have given their approval.

To prepare the assessment process, the process coordinator convened with management of the programme to discuss the outline of the self-assessment report, the subjects to be addressed in this report and the site visit schedule. In addition, the planning of the activities in preparation of the site visit were discussed. In the course of the process preparing for the site visit, programme management and the Certiked process coordinator regularly had contact to fine-tune the process. The activities prior to the site visit have been performed as planned. Programme management approved of the site visit schedule.

Well in advance of the site visit date, programme management sent the list of final projects of graduates of the programme of the most recent years. Acting on behalf of the assessment panel, the process coordinator selected the theses of 15 graduates from the last two years. The grade distribution in the selection was ensured to conform to the grade distribution in the list, sent by programme management.

The panel chair and the panel members were sent the self-assessment report of the programme, including appendices. In the self-assessment report, the student chapter was included. In addition, the expert panel members were forwarded a number of theses of the programme graduates, these theses being part of the selection made by the process coordinator.

Several weeks before the site visit date, the assessment panel chair and the process coordinator met to discuss the self-assessment report provided by programme management, the procedures regarding the assessment process and the site visit schedule. In this meeting, the profile of panel chairs of NVAO was discussed as well. The panel chair was informed about the competencies, listed in the profile. Documents pertaining to a number of these competencies were presented to the panel chair. The meeting between the panel chair and the process coordinator served as the briefing for panel chairs, as meant in the NVAO profile of panel chairs.

Prior to the date of the site visit, all panel members sent in their preliminary findings, based on the self-assessment report and the final projects studied, and a number of questions to be put to the programme representatives on the day of the site visit. The panel secretary summarised this information, compiling a list of questions, which served as a starting point for the discussions with the programme representatives during the site visit.

The panel found the self-assessment report to be somewhat less explicit in presenting the genuine profile and the essential characteristics of the programme.

Shortly before the site visit date, the complete panel met to go over the preliminary findings concerning the quality of the programme. During this preliminary meeting, the preliminary findings of the panel members, including those about the theses were discussed. The procedures to be adopted during the site visit, including the questions to be put to the programme representatives on the basis of the list compiled, were discussed as well.

On 17 September 2018, the panel conducted the site visit on the Eindhoven University of Technology campus. The site visit schedule was as planned. In a number of separate sessions, the panel was given the opportunity to meet with the Departmental Board, programme management, Examination Committee members, lecturers and final projects examiners, and students and alumni.

In a closed session near the end of the site visit, the panel considered every one of the findings, weighed the considerations and arrived at conclusions with regard to the quality of the programme. At the end of the site visit, the panel chair presented a broad outline of the considerations and conclusions to programme representatives.

Clearly separated from the process of the programme assessment, the assessment panel members and programme representatives met to conduct the development dialogue, with the objective to discuss future developments of the programme.

The assessment draft report was finalised by the secretary, having taken into account the findings and considerations of the panel. The draft report was sent to the panel members, who studied it and made a number of changes. Thereupon, the secretary edited the final report. This report was presented to programme management to be corrected for factual inaccuracies. Programme management were given two weeks to respond. Having been corrected for these factual inaccuracies, the Certiked bureau sent the report to the University Board to accompany their request for re-accreditation of this programme.

3. Programme administrative information

Name programme in CROHO:	B Chemical Engineering and Chemistry (Scheikundige Technologie)
Orientation, level programme:	Academic Bachelor
Grade:	BSc in Chemical Engineering
Number of credits:	180 EC
Specialisations:	N.A.
Location:	Eindhoven
Mode of study:	Full-time (language of instruction English)
Registration in CROHO:	21PG-56960
Name of institution:	Eindhoven University of Technology
Status of institution:	Government-funded University
Institution's quality assurance:	Approved

4. Findings, considerations and assessments per standard

4.1 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.

Findings
The Bachelor Chemical Engineering and Chemistry programme is one of the programmes offered by the Department of Chemical Engineering and Chemistry of Eindhoven University of Technology. The Dean has the responsibility for the programme quality. The programme director, assisted by the programme coordinator, takes care of the day-to-day management of the programme. The Programme Committee, consisting of an equal number of lecturers and students, advises programme management on quality issues. The Examination Committee has the authority to ensure the quality of examinations and assessments of the programme. The Programme Committee and the Examination Committee are shared by this Bachelor programme and the Master Chemical Engineering programme.

The programme is a three-year, research-based, fundamental bachelor programme in both the chemistry and chemical engineering domains. The objectives of the programme are to educate students in both domains, allowing them to be introduced to the chemistry and chemical engineering fundamentals and to acquire knowledge and skills to study subjects and to address problems in both fields. As students are educated in both domains, the programme may be considered to be rather broad. The breadth is one of the major objectives of programme management.

The objectives of the programme conform to the domain-specific reference framework for the chemical sciences in the Netherlands, which has been drafted by the joint programmes of this assessment cluster in the Netherlands. In this domain-specific framework, reference has been made to international frameworks and benchmark statements. This Eindhoven University of Technology programme may be regarded to be placed in the chemistry and chemical engineering sub-domains of the chemical sciences.

The programme has been accredited by the international Institution of Chemical Engineers (IChemE) and has been granted the Eurobachelor label by the European Chemistry Thematic Network (ECTN). These award signify the programme meeting international standards in this domain.

The programme aims primarily to educate students to continue their studies at master level. Programme graduates may enter all master chemical engineering programmes in the Netherlands or programmes in these fields abroad. They may also qualify for other master programmes in natural sciences, when they incorporate specific transfer courses in their electives' space.

The programme keeps abreast of current trends in the professional field, maintaining relations with industry. The objectives of the programme are to prepare students not directly for the labour market, but only after having completed one of the master programmes in this or other domains. In the Master

Chemical Engineering programme of Eindhoven University of Technology, students may continue their studies in either chemistry or chemical engineering.

The programme objectives have been translated into the intended learning outcomes of the programme. The intended learning outcomes specify, among others, fundamental knowledge and understanding of the chemistry and chemical engineering domains, knowledge and skills of scientific research in these domains, and academic and professional skills, such as critical thinking, communication skills and collaborative skills in multidisciplinary teams.

Programme management drafted a table from which the correspondence of the intended learning outcomes to the Dublin descriptors for bachelor programmes may be inferred.

Considerations
The panel considers the programme objectives to be sound. The panel especially welcomes the broadness of the programme, allowing students to acquire knowledge and understanding of both the chemistry and chemical engineering domains and also allowing students to continue their studies in one of these domains at master level. The panel considers this bachelor-master trajectory to be a very valuable concept.

The objectives of the programme are within the boundaries of the domain-specific reference framework for academic Chemical Sciences programmes. The panel appreciates the efforts by the joint programmes in Chemical Sciences in the Netherlands to draft this framework and regards this to be a sound and up-to-date description of this domain. The profile of this Eindhoven University of Technology programme may be clearly distinguished within the framework.

The programme meeting international domain-specific standards in the programme domain is appreciated by the panel.

The panel understands and supports the programme position to educate students to continue their studies at master level and not so much to enter the labour market. At the same time, the panel acknowledges the relevance for the programme to monitor current trends in industry. In addition, the panel advises to formulate future trends, relevant for the programme, in more clear terms to allow the programme to adjust to these trends.

The objectives have been well-translated into the intended learning outcomes of the programme. They cover the programme objectives appropriately and are stated in clear terms. The intended learning outcomes conform to the bachelor level.

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

4.2 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.

Findings
The number of incoming students in the programme has risen gradually, going from 77 students in 2012 to somewhat over 100 students per year in 2016 and 2017. The vast majority of students have the Dutch pre-university secondary education diploma. Since 2017, the programme is offered in English, leading to a marked increase of international students (17 students in 2017). About 25 % of the students are female. The current number of incoming students is within the limits, set by the facilities and buildings available to accommodate students' education.

The curriculum has a study load of 180 EC and takes three years to complete. Programme management presented a table, mapping the intended learning outcomes to the curriculum components. The curriculum has been organised in line with the Bachelor College structure, which applies to all bachelor programmes of the university. The curriculum is composed of major courses (90 EC), academic and professional skills (5 EC, training of these skills is part of the major courses), university-wide generic courses (25 EC), user, society and enterprise courses (USE, 15 EC) and electives (45 EC). The major courses are domain-specific and address the chemistry and chemical engineering subjects. These courses correspond to the research interests of the Department, being chemical and process technology and molecular science and material chemistry. Academic and professional skills include presentation, academic writing and planning skills. In the generic courses, students study mathematics, applied physics, ethics, history of technology, engineering design and data analytics. User, society and enterprise courses introduce students to societal and entrepreneurial dimensions of their field of study. The elective courses allow students to deepen their knowledge of either chemical and process technology or molecular and material chemistry, preparing them for the master specialisation of their choice. They may also select, among others, biomedical engineering, mathematics or applied physics courses, offered by other departments. The Bachelor final project (10 EC) is the final component of the curriculum, requiring students to do an individual research project. Students are stimulated to complete their Bachelor final project abroad. Some 15 % of the students do so. If spent abroad, the study load of the project is 15 EC. New trends, such as scientific computing and automation of chemical plants, are researched by the lecturers and are gradually introduced in the curriculum.

About 39 lecturers are involved in the programme. Lecturers are active researchers, doing research within one of the research groups of the Department of Chemical Engineering and Chemistry. All of the lecturers in the programme are PhDs. The proportion of lecturers being BKO-certified is about 67 %, whereas another 13 % of the lecturers are in the process of obtaining their BKO-certificate. In addition to this permanent staff, about 190 PhD students spend 10 % of their time on teaching in the programme, supervising students in projects and in guided self-study classes. Survey results show students to be very appreciative of the domain-specific and professional field knowledge, and of the teaching qualities of the lecturers. Part-time lecturers from industry are involved in the courses.

Applicants having the Dutch pre-university secondary school diploma in either the natural sciences & technology subject cluster or the natural sciences & health subject cluster with mathematics B and physics are unconditionally admitted to the programme. Students having completed the propaedeutic year of higher vocational education institutes are admitted, if they show pre-university secondary school mathematics B, physics and chemistry certificates. Applicants coming from abroad have to be proficient in English and have to report appropriate pre-university training, being in line with Nuffic- and Naric-standards. Programme management schedules a number of information events to inform prospective students about the programme. Before entering, applicants complete the study-choice check activities, which include individual interviews by programme staff with every one of the applicants. Prospective students are stimulated to reflect on their choice for this programme. In pre-described procedures and on the basis of documented requests, the programme Examination Committee grants exemptions.

The programme educational concept is to offer individual, activating, research-based and design-oriented education. The average number of hours of face-to-face education in the curriculum is 24 hours per week. The study methods are selected in line with the educational concept and include lectures, tutorials, guided self-study, practical classes and design-based learning projects. Guided self-study is meant for students to do exercises. In tutorials and in design-based learning projects, students do close-ended or open-ended assignments in small groups. The credits spent on practical classes are about 10 % to 15 % of the curriculum. The laboratory facilities are kept up-to-date. New, computer-based study methods are being introduced. At least two lecturers are involved in the courses. In the first part of the first year, students may turn to the student mentor for advice. Later in the curriculum, this guidance becomes less intensive. Study coaches, being staff members, guide students in the choices to be made in the curriculum. The academic advisor of the Department monitors study progress. The overall students-to-staff ratio is 16 : 1 (on basis of total fte's). In the first year, students have to report 45 EC. If they do not succeed, they have to leave the programme. The first year is quite demanding. About 22 % of the students are forced to leave. The student success rates after three years are on average about 40 % and after four years they are on average 68 %, rising to 81 % for the 2013-cohort (figures for last three to four cohorts, proportions of students re-enrolling in second year). Students regard the programme to be feasible.

Considerations
The panel regards the number of incoming students in the programme to be favourable, this number being within the programme capacity limits.

The curriculum matches the intended learning outcomes of the programme. The panel appreciates the contents of the curriculum, especially noting the courses to be seriously designed and to be solid in terms of contents. The panel regards the curriculum to be research-based and to be up-to-date, new trends being incorporated. The curriculum is coherent, the Bachelor College structure being welcomed by the panel. The panel is positive about the academic and professional skills being addressed in the curriculum and encourages the programme to continue along this path.

The lecturers in the programme are experienced and well-reputed researchers and skilled teachers. They are all PhDs and are engaged in current, relevant research, referring to their research in the lectures. Their educational capabilities are regarded by the panel to be up to standard. The panel notes the capacities of the lecturers to be appreciated by the students.

The entry requirements and admission procedures of the programme are appropriate. The panel welcomes the elaborate information provided for prospective students on the part of the programme.

The educational concept and the study methods of the programme are adequate and varied, promoting student-activating learning. The panel is also positive about new computer-based study methods being introduced. The panel suggests to monitor the number of practical classes in the curriculum to keep this number at required levels. The panel notes the programme to invest in practical facilities. The students-to-staff ratio and the number of hours of face-to-face education in the programme meet the standards. The study guidance by student mentors, study coaches and the study advisor is up to standard. The panel considers the programme to be feasible, appreciating the binding study advice in the first year of 45 EC. The student success rates are appropriate in the last years.

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

4.3 Standard 3: Student assessment

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

Findings
The examinations and assessments in the programme are governed by the Education and Examination Regulations for the programme, drafted by the Board of the Department of Chemical Engineering and Chemistry and by the Rules and Regulations of the Examination Committee for the programme. Both of these documents comply with Eindhoven University of Technology guidelines. As has been indicated, the Examination Committee has the authority to ensure the quality of examinations and assessments of the programme.

In the programme, both summative and formative examinations are organised. In the first and second year courses, intermediate, formative examinations are scheduled to promote study progress. Methods for summative examinations are aligned with the course goals and meet the knowledge, understanding and skills to be assessed. The examination methods include written examinations (open-book and closed-book), written assignments, written reports, practical assignments and oral presentations. In case of group work, individual performances by students are assessed by means of individual written reports or oral assessments. The programme is experimenting with electronic assessments. These experiments are monitored by the Examination Committee.

The Bachelor final project is an individual design, modelling or research project. Students conduct this project either in one of the research groups of the Department of Chemical Engineering and Chemistry or at partner universities abroad. Students are entitled to their individual supervisor. Day-to-day supervisors may be PhD students, acting under the responsibility of supervisors. The projects are assessed on the basis of, among others, theoretical insights, scientific level, self-reliance and project execution. Both the written report and the oral defence are assessed. The project is assessed by an assessment committee, composed of at least the supervisor and the second reader, both of them being Department staff members. For their assessments, they use a scoring form.

In the programme, measures are being taken to ensure the validity, reliability and transparency of examinations and assessments. Examinations drafted by one examiner are peer-reviewed by another examiner. Model answers for the assessments are included. In most instances, a number of examiners are involved in the assessments. The Examination Committee makes analyses of examinations in case of deviant grade distributions. Fraud or plagiarism cases in the programme are handled by the Examination Committee. Only few cases occurred the last few years.

Considerations
The panel considers the examination and assessment policies for the programme to be appropriate, these being in line with the Eindhoven University of Technology guidelines. The position and authority of the programme Examination Committee are adequate, this committee being in control of the examinations and assessments of the programme.

The panel approves of the examination methods adopted in the programme, noting these are consistent with the goals and the contents of the courses.

The supervision and assessment processes for the Bachelor final projects are well-organised. Students are offered appropriate supervision. The assessment procedures are up to standard, involving at least two examiners and being conducted using scoring forms with relevant criteria. The panel advises to add more extensive written comments to the scoring forms to substantiate the grades.

The measures taken to ensure the validity, reliability and transparency of examinations and assessments are adequate. The fraud and plagiarism formalities are up to standard.

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

4.4 Standard 4: Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.

Findings
The panel studied the examinations of a number of courses of the programme.

The panel also reviewed the Bachelor final projects of fifteen graduates of the programme with different grades. In the Bachelor final projects, students have to demonstrate to be able to conduct an individual design, modelling or research project within the domain of the programme.

As has been indicated, graduates of the programme may enter master chemical engineering programmes in the Netherlands or programmes in these fields abroad. They may also qualify for other master programmes in natural sciences. The vast majority of the graduates (about 90 %) continue their studies in the Master Chemical Engineering programme of Eindhoven University of Technology.

Considerations
The panel regards the course examinations, which were reviewed by panel members, to be challenging.

The panel supports the grades awarded to the Bachelor final projects by the programme examiners. The panel considers these projects to be well-elaborated and well-founded.

The panel is convinced that students having completed the programme reached the intended learning outcomes and regards the graduates of this programme to be very well prepared to continue their studies at master level in this domain. The panel is positive about the range of master programmes graduates are admitted to.

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

5. Overview of assessments

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

6. Recommendations

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

- To formulate future trends, relevant for the programme, in more clear terms to allow the programme to adjust to these trends.
- To continue to promote in the curriculum the students' education in academic and professional skills, such as presentation, academic writing and collaborative skills.
- To monitor the number of practical classes in the curriculum to keep the number of these classes at required levels.
- To add more extensive written comments to the scoring forms of the Bachelor final projects to substantiate the grades.