

Assessment report  
Limited Framework Programme Assessment

**Master Chemistry**

Leiden University

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## 1. Executive summary

In this executive summary, the panel presents the main considerations, which led to the assessment of the quality of the Master Chemistry programme of Leiden University. 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 appreciates the programme to be strongly focussed on the study of specific chemistry disciplines or themes within the chemical sciences domain. The panel welcomes the strong research orientation, the programme being well-aligned with new scientific trends in these disciplines. The programme is tuned to international developments in research in medical applications (chemical biology) and research in industry (energy and sustainability). Students are offered ample opportunities to tailor the programme to their preferences, both in terms of the research themes and in terms of the specialisations offered.

The panel regards the programme profile to be well-delineated, but suggests to communicate this profile more clearly in relation to other Dutch and foreign programmes.

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 Leiden University programme may be clearly distinguished within the framework.

The panel appreciates students being given opportunities to prepare not only for PhD positions, but also for positions as managers, fully-qualified teachers in chemistry in Dutch secondary education or science communication specialists.

The intended learning outcomes of the programme are aligned to the programme objectives, are well-articulated and conform to the master level.

The panel notes the number of incoming students to be adequate.

The curriculum matches the intended learning outcomes of the programme. The panel regards the contents of the curriculum to be solid and up to standard. The curriculum is coherent, the specialisations being well-organised and well-integrated. The academic skills are well-represented. The panel advises to check the presentation skills of students coming from non-Leiden-Delft bachelor programmes. The panel is positive about students being allowed to tailor the curriculum to their preferences and to select their research project subjects early in the programme at one of the Leiden Institute of Chemistry research groups. The panel also welcomes students attending a fair number of Thesis Talks and colloquia.

The lecturers in the programme are researchers of international standing. Their educational capabilities are definitely up to standard. The number of staff in the programme is sufficient.

The admission requirements and procedures are appropriate. Incoming students are well-informed.

The study methods are adequate, promoting student-activating learning processes. The students-to-staff ratio is very generous and the number of hours of face-to-face education meets the standards. The study guidance by the mentors is very much appreciated by the panel. The panel regards the programme to be feasible and the study load to be evenly distributed. The student success rates are appropriate.

The panel regards the examination and assessment regulations for the programme to be appropriate.

The panel approves of the examination methods adopted by the programme, noting these to be consistent with the goals and the contents of the courses.

The supervision and assessment processes for the Research Training Projects are well-organised. The panel especially welcomes the involvement of the independent jury in the assessments and the rubrics scoring forms adopted.

The panel considers the measures to ensure the validity, reliability and transparency of examinations and assessments to be adequate. The Board of Examiners is pro-active in enforcing these measures and the examiners comply with the procedures.

The examinations of the courses are up to standard. The panel endorses the grades for the Research Training Projects. The panel considers these projects to be of quite advanced nature and to be definitely at master level.

The panel is convinced that students having completed the programme reached the intended learning outcomes. The programme graduates are well-educated and have very good analytical skills. The panel is positive about the proportion of graduates proceeding to PhD trajectories. The career perspectives of the programme graduates are very favourable.

The panel suggests to install an advisory board with professional field representatives to better remain abreast of trends in the professional practice.

The panel which conducted the assessment of the Master Chemistry programme of Leiden University 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, 7 March 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 Leiden University to support the limited framework programme assessment process for the Master 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 Master Chemistry programme of Leiden University, 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. R.M.J. Liskamp, professor, chair Chemical Biology and Medicinal Chemistry, School of Chemistry, University of Glasgow, United Kingdom, professor of Molecular Medicinal Chemistry, Utrecht University (panel member);
- Drs. O. de Vreede, head Innovation and Human Capital, VNCI, Association of the Dutch Chemical Industry (panel member);
- A.E.M. Melcherts BSc, student Master in Nanomaterials Science, Utrecht University (student member).

On behalf of Certiked, drs. W. Vercoouteren 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 few 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.

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 10 October 2018, the panel conducted the site visit on the Leiden University campus. The site visit schedule was as planned. In a number of separate sessions, the panel was given the opportunity to meet with Faculty Board representatives, programme management, Board of Examiners members, lecturers and final projects examiners, and students and alumni.

In a closed session at 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.

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 Board of Leiden University, to accompany their request for re-accreditation of this programme.

### 3. Programme administrative information

Name programme in CROHO: M Chemistry  
Orientation, level programme: Academic Master  
Grade: MSc  
Number of credits: 120 EC  
Specialisations: Research  
Education  
Business Studies  
Science Communication and Society  
Location: Leiden  
Mode of study: Full-time (language of instruction English)  
Registration in CROHO: 21PB-66857

Name of institution: Leiden University  
Status of institution: Government-funded University  
Institutions' 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 Master Chemistry programme is offered by Leiden Institute of Chemistry of the Faculty of Science of Leiden University. The dean of the Faculty has the responsibility for all programmes of the Faculty. Leiden Institute of Chemistry offers the joint degree Bachelor programmes Molecular Science and Technology and Bachelor Life Science and Technology in collaboration with Delft University of Technology, as well as the Master Chemistry and Master Life Science and Technology programmes. The education director of the Master Chemistry programme is responsible for the delivery and quality of the programme. The Board of Examiners, Education Committee and Board of Admission are organised jointly for the Master Chemistry and Master Life Science and Technology programmes. The Education Committee, consisting of an equal number of lecturers and students, advises programme management on quality issues. The Board of Examiners is responsible for ensuring the quality of examinations and assessments of the programme. The Board of Admission of the programme screens the applications of students.

The Master Chemistry is a two-year, research-based, academic master programme in chemistry. The programme is solidly rooted in the research done at Leiden Institute of Chemistry. Students in the programme are offered four specialisations, two research themes and electives to adapt the programme to their preferences. The overarching objectives of the programme are to educate students as chemists, with a strong focus on research in chemistry and with emphasis on research training and science methodology. Students may select one of the four specialisations offered, being Research, Education, Business Studies, Science Communication and Society. The Research specialisation educates students in either Chemical Biology or Energy & Sustainability research themes. The Chemical Biology research theme addresses biological processes at the molecular level to strengthen the knowledge base of human health and disease. The Energy & Sustainability research theme is directed towards fundamental study of chemical reactions related to sustainable and efficient production, storage and usage of energy. The Education specialisation trains students to become fully-qualified teachers in chemistry in Dutch secondary education. In the Business Studies specialisation, students are educated to contribute to managerial decision-making in chemical industry. The Science Communication and Society specialisation prepares students for careers in science communication and popularisation.

The objectives of the programme are 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 Leiden University programme may be regarded to be positioned in the chemistry sub-domain of chemical sciences.

The programme aims to prepare students in the Research specialisation primarily for PhD positions, to be followed by jobs in chemical industry. Students from the other specialisations are trained for positions as teachers in secondary education, managers in industry or science communication specialists.



The programme objectives have been translated into intended learning outcomes. These specify, among others, knowledge and understanding of theoretical concepts of chemistry pertaining to either chemical biology or energy and sustainability, research skills in this discipline, critical scientific attitude, written and oral communication skills, social and ethical awareness and self-development competences. For the Education, Business Studies and Science Communication and Society specialisations, additional intended learning outcomes have been formulated, stating the specific learning outcomes to be acquired by these students. In a formal sense, the specific education, business and science communication parts of these specialisations are offered under the responsibilities of other institutes, both within and outside of the Faculty of Science.

#### *Considerations*

The panel considers the programme objectives to be sound. The panel appreciates the programme to be strongly focussed on the study of specific chemistry disciplines or themes within the chemical sciences domain. In addition, the panel welcomes the strong research orientation of the programme. Research is prominent in the programme, the programme being well-aligned with new scientific trends in these disciplines. Through these relations, the programme is also tuned to international developments in research in medical applications (chemical biology) and in research in industry (energy and sustainability).

Students are offered ample opportunities to tailor the programme to their preferences, both in terms of the research themes Chemical Biology or Energy & Sustainability and in terms of the Research, Education, Business Studies or Science Communication and Society specialisations.

The panel regards the programme profile to be well-delineated, but suggests to communicate this profile more clearly in relation to other Dutch and foreign programmes.

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 Leiden University programme may be clearly distinguished within the framework.

The panel appreciates students being given opportunities to prepare not only for PhD positions, but also for positions as managers, fully-qualified teachers in chemistry in Dutch secondary education or science communication specialists.

The intended learning outcomes of the programme are aligned to the programme objectives. The panel regards the intended learning outcomes to be well-articulated. The intended learning outcomes are conform to the master level.

#### *Assessment of this standard*

These considerations have led the assessment panel to assess standard 1, Intended learning outcomes, to be satisfactory.

## 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*

Over the last eight years, the number of incoming students in the programme remained rather stable at about 40 students per year. The proportion of female students is 30 %. About 50 % to 60 % of the students come from the Leiden-Delft joint-degree Bachelor Molecular Science and Technology programme. About 10 % of the incoming students are from higher vocational education institutes. The proportion of international students is 10 % to 15 % of total inflow. The programme wants to raise the latter proportion to about 25 %, in line with Faculty policy. The majority of the students enter the Research specialisation (60 % to 70 %). About 20 % opt for the Business Studies specialisation. The other students select one of the other specialisations.

The curriculum has a study load of 120 EC and takes two years to complete. Programme management presented a table, mapping the intended learning outcomes to the curriculum components. The curriculum of the Research specialisation is composed of the compulsory core courses (24 EC), the Academic Writing (2 EC), Science Methodology (4 EC) and Essay and Colloquium courses (6 EC), elective courses (4 EC to 24 EC), and the Research Training Project (60 EC to 80 EC). Students ought to take the core courses in the research area of their choice, being Chemical Biology or Energy & Sustainability. In the Academic Writing and Science Methodology courses, students are trained in academic writing skills and in essentials of methodology. In the Essay and Colloquium course, students review literature and present their findings before an audience of fellow students and an independent jury. Students take elective courses. The main component of the curriculum is the Research Training Project (60 EC to 80 EC), which may be split in the major research project (40 EC to 60 EC) and the minor research project (20 EC to 40 EC). Academic skills are addressed in the courses mentioned, but also in other courses, as students have to critically review research papers and present their findings. Students have to attend at least ten colloquia and at least ten Thesis Talks, being Research Training Projects presentations. New trends, such as digitalisation, neural networks and machine learning, are addressed in the programme curriculum. The other specialisations have somewhat differently organised curricula, the Research Training Project study load being less than mentioned and the Essay and Colloquium course being left out to make room for specialisation-oriented courses and internships (40 EC to 60 EC in total).

About 47 staff members are involved in the programme as lecturers, research supervisors, jury members or as committee members. All of them have a PhD degree and most of them are actively engaged in current, international research in their fields, working at the research groups of Leiden Institute of Chemistry. The proportion of lecturers being BKO-certified is about 75 %, another 13 % of the lecturers being in the process of acquiring the certificate. In addition to the permanent staff, postdocs and PhD students act as teaching assistants in tutorials and research training projects. Recently, lecturers without research obligations, but nevertheless embedded in research groups, were recruited. Lecturers involved in the Chemical Biology or in the Energy & Sustainability research theme core courses meet regularly to evaluate these courses. Within Leiden Institute of Chemistry, regular meetings are scheduled to discuss this and the other programmes.

Prospective students are informed about the programme through the programme website and during the Master Open Day, scheduled twice per year. Applicants who have completed the Leiden-Delft Bachelor Molecular Science and Technology programme are admitted unconditionally. Other applications are screened by the programme Board of Admission. Applications of students with Dutch bachelor degrees in chemistry-related fields are accepted, if the contents of their programme are equivalent to the Leiden-Delft Bachelor programme. Applications of students having non-Dutch bachelor degrees in chemistry or in related fields are admitted, if their knowledge is equivalent to Dutch bachelor degrees and if their academic backgrounds are up to standard. These students are to submit a letter of motivation and are to report proficiency in English. Applications by students coming from higher vocational education institutes are accepted, if they report at least 7.5 as average final grade and at least 8.0 for the bachelor thesis. These students have to submit a letter of motivation and a letter of recommendation from their mentor. Students whose prior education differs by not more than 30 EC from the Bachelor Molecular Science and Technology programme, but who report outstanding results, may be admitted to the programme after having completed the 30 EC pre-master programme.

The educational concept of the programme is research-based learning and promotes students to engage in active learning, self-discipline and dedication. At the beginning of the programme, students are informed about these principles. The academic year is divided in four periods, courses being scheduled in one of these periods with seven weeks of classes and two weeks of examinations. The number of hours of face-to-face education is on average 7.5 to 8.0 hours per week for the whole curriculum. Study methods adopted in the courses are lectures, exercises, practical work, discussions, presentations and self-study. Most courses are small-scale, but some may include larger classes. The students-to-staff ratio is 4.7 : 1 not counting exchange students. Additionally, the staff is involved in teaching and supervision of students of the Bachelor programmes Molecular Science and Technology, Life Science and Technology and Bio-Farmaceutische Wetenschappen. New facilities are available for the programme. Students may compose the curriculum tailored to their preferences. They are guided in drafting their study plan by their mentor, being a Leiden Institute of Chemistry staff member. The mentor often is the supervisor of the Research Training Project. The mentors are greatly appreciated by students. In addition, students may turn to the recently appointed study advisor in case of study problems or personal issues. The student success rates after two years are on average 28 % and on average 72 % after three years (figures for last cohorts). The mean study duration is 2.5 years.

### *Considerations*

The panel notes the number of incoming students to be adequate.

The curriculum matches the intended learning outcomes of the programme. The panel regards the contents of the curriculum to be solid and up to standard. The curriculum is coherent, the specialisations being well-organised and well-integrated. The academic skills are well-represented. The panel advises to check the presentation skills of students coming from non-Leiden-Delft bachelor programmes. The panel is positive about students being allowed to tailor the curriculum to their preferences and to select their research project subjects early in the programme at one of the Leiden Institute of Chemistry research groups. The panel also welcomes students attending a fair number of Thesis Talks and colloquia.

The lecturers in the programme are researchers of international standing. The panel considers the educational capabilities of the lecturers to be definitely up to standard. The number of staff in the programme is sufficient.

The entry requirements and admission procedures of the programme are appropriate. Incoming students are well-informed about the programme.

The panel considers the study methods of the programme to be adequate, promoting student-activating learning processes. The students-to-staff ratio is very generous and the number of hours of face-to-face education in the programme meets the standards. The study guidance by the mentors is very much appreciated by the panel, allowing students to design consistent curricula. The panel regards the programme to be feasible and the study load to be evenly distributed. The student success rates are appropriate.

*Assessment of this standard*

These considerations have led the assessment panel to assess standard 2, Teaching-learning environment, to be good.

### 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 Examination Rules and Regulations for the programme and correspond with the Faculty of Science rules and regulations. The Board of Examiners has the authority to ensure the quality of the examinations and assessments of the programme.

The examination methods in the courses are, among others, written examinations, essays, research proposals, presentations, and participation in class. In a number of courses, multiple examinations are scheduled.

The Research Training Projects are individual research projects. Students must conduct the major projects at one of the research groups of the Leiden Institute of Chemistry. Minor research projects may be done at other institutes as well, including institutes abroad. These minor projects may only be carried out with Board of Examiners consent and when assessed by Leiden Institute of Chemistry staff members. Students are presented topics at thesis markets, scheduled two times per year. The projects are supervised by supervisors of one of the research groups of Leiden Institute of Chemistry. Day-to-day supervisors may be PhD students, acting under the responsibility of supervisors. Students may present draft versions of the thesis two or three times in the process. At completion of the project, students submit the written report and present their results in the so-called Thesis Talk. The project is assessed by the supervisor and a second, independent examiner. Reports are checked for plagiarism. The report is also studied by a jury comprising two independent researchers and the Thesis Talk is held before this jury and fellow students. The examiners propose the grade to the jury. This research project assessment process ensures grades being calibrated across different research groups. A rubrics scoring form is adopted for the assessment, which includes as assessment criteria scientific knowledge, scientific attitude, performance in research, personal skills, report and presentation.

In the programme, measures have been taken to ensure the validity, reliability and transparency of examinations and assessments. The education director informs lecturers about the procedures. Examinations drafts are peer-reviewed by fellow examiners. Examiners make use of test matrices. The Board of Examiners on a regular basis inspects samples of course examinations, minor theses and major theses to verify if the learning goals are met.

#### *Considerations*

The panel regards the examination and assessment regulations for the programme to be appropriate.

The panel approves of the examination methods adopted by the programme, noting these to be consistent with the goals and the contents of the courses.

The supervision and assessment processes for the Research Training Projects are well-organised. Students are offered appropriate supervision and the assessment procedures are definitely up to standard. The panel especially welcomes the involvement of the independent jury of two members in the assessments and the rubrics scoring forms adopted.

The panel considers the measures to ensure the validity, reliability and transparency of examinations and assessments to be adequate. The Board of Examiners is pro-active in enforcing these measures and the examiners comply with the procedures.

*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.
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##### *Findings*

The panel studied a number of course examinations.

The panel reviewed the major Research Training Projects of fifteen graduates of the programme with different grades. In these projects, students are expected to demonstrate being able to execute a substantial research project independently, studying and digesting specialist literature, formulating hypotheses, performing experiments, acquiring and analysing data, and reporting on the results.

In the last two to three years, about 50 % of the programme graduates co-authored scientific publications.

The proportion of cum laude awarded is relatively substantial. The Board of Examiners is considering measures to limit this proportion.

Programme graduates find suitable positions quite easily. Over 50 % of the programme graduates proceed to PhD trajectories. Most graduates either directly or after having completed their PhD, start careers in industry. Some students continue their careers as teachers or communication specialists. The vast majority of the programme alumni (about 80 %) consider the programme to be a good preparation for their careers.

##### *Considerations*

The examinations of the courses studied by the panel are up to standard.

The panel endorses the grades for the Research Training Projects, supporting, however, the measures to limit the proportion of cum laude. The panel considers these projects to be of quite advanced nature and to be definitely at master level.

The panel is convinced that students having completed the programme reached the intended learning outcomes. The programme graduates are well-educated and have very good analytical skills. The panel is positive about the proportion of graduates proceeding to PhD trajectories. The career perspectives of the programme graduates are very favourable.

The panel suggests to install an advisory board with professional field representatives to better remain abreast of trends in the professional practice.

##### *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	Satisfactory
Standard 2: Teaching-learning environment	Good
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 further clarify the programme profile in relation to other Dutch and foreign programmes.
- To check the presentation skills of students coming from other than Leiden-Delft Bachelor programmes.
- To install an advisory board with professional field representatives to better remain abreast of trends in the professional practice.