Commission
des titres d'ingénieur

Evaluation report

Katholieke Universiteit te Leuven
Faculty of Engineering Science
KU Leuven

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For your information :

*The CTI evaluation reports are written in unjustified layout, in order to facilitate the reading for people suffering from dyslexia.

Name of the institution: Katholieke Universiteit te Leuven
Acronym: KU Leuven
Country: Belgium
Institution's head office: Leuven

CTI accreditation application, campaign: 2021-2022

"Admission par l'Etat" and EUR-ACE© Label

I. Scope of the evaluation procedure

Following bachelor's programmes have been evaluated but are not eligible for admission by the French state or for the EUR-ACE© label:

Application category	Programme	Pathway
Bachelor's	Bachelor of Engineering	Initial engineering training under student status
Bachelor's	Bachelor of Engineering: Architecture	Initial engineering training under student status

Following programmes have been evaluated but are not eligible for admission by the French state or for the EUR-ACE© label:

Application category	Programme	Pathway
Advanced master's	Advanced Master of Urbanism, Landscape and Planning	Initial engineering training under student status
Advanced master's	Advanced Master of Human Settlements	Initial engineering training under student status
Advanced master's	Advanced Master of Conservation of Monuments and Sites	Initial engineering training under student status

Accreditation application for the renewal or the first admission by the French state and the EUR-ACE© label for the following programmes:

Application category	Programme	Pathway
Renewal Admission par l'Etat (RAD)	Master of Engineering: Architecture	Initial engineering training under student status
Renewal Admission par l'Etat (RAD)	Master of Biomedical Engineering	Initial engineering training under student status
Renewal Admission par l'Etat (RAD)	Master of Engineering: Civil Engineering	Initial engineering training under student status
Renewal Admission par l'Etat (RAD)	Master of Engineering: Chemical Engineering	Initial engineering training under student status
Renewal Admission par l'Etat (RAD)	Master of Engineering: Electrical Engineering	Initial engineering training under student status
Renewal Admission par l'Etat (RAD)	Master of Engineering: Energy	Initial engineering training under student status

Renewal Admission par l'Etat (RAD)	Master of Engineering: in Materials Engineering	Initial engineering training under student status
Renewal Admission par l'Etat (RAD)	Master of Engineering: Mechanical Engineering	Initial engineering training under student status
Renewal Admission par l'Etat (RAD)	Master of Engineering: Mathematical Engineering	Initial engineering training under student status
Renewal Admission par l'Etat (RAD)	Master of Nanoscience, Nanotechnology and Nanoengineering	Initial engineering training under student status
New Admission par l'Etat (NAD)	Master of Engineering: Computer Science	Initial engineering training under student status
New Admission par l'Etat (NAD)	Master of Engineering: Mobility and Supply Chain Engineering	Initial engineering training under student status

Accreditation application of the institution to be awarded the EUR-ACE© label for the following programmes:

Application category	Programme	Pathway
Renewal EUR-ACE© label (REU)	EIT-KIC Master in Energy	Initial engineering training under student status
Renewal EUR-ACE© label (REU)	Erasmus Mundus Master of Science in Nanoscience and Nanotechnology	Initial engineering training under student status
Renewal EUR-ACE© label (REU)	Advanced Master of Nuclear Engineering	Initial engineering training under student status
Renewal EUR-ACE© label (REU)	Advanced Master of Safety Engineering	Initial engineering training under student status
Renewal EUR-ACE© label (REU)	Advanced Master of Artificial Intelligence	Initial engineering training under student status

II. Presentation of the faculty

The engineering faculties of three Flemish universities (VUB, UGent, KU Leuven) applied for the renewal of a CTI evaluation with the aim to have their master's programmes recognised in France via the "Admission par l'Etat" procedure and at the European level through the Eur-Ace® Label. These degrees are awarded after the completion of a 5-year programme involving a 3-year general science and technology undergraduate degree (bachelor's), followed by a 2-year specialisation resulting in the master's degree.

General description of the faculty
KU Leuven is one of the oldest universities in Europe. The research-oriented institution was established in 1425 as the "Studium generale Lovaniense." In 1833, it was reformed and renamed "Katholieke Universiteit Leuven" and included a large French-speaking section. Following a political crisis, the francophone sections of Leuven split from the university in 1968 and the "Université Catholique de Louvain" was established on the new campus in Louvain-la-Neuve. The "Katholieke Universiteit te Leuven" later adopted the official name "KU Leuven". During the 2021-2022 academic year, 26 706 students were enrolled in bachelor's programmes and 20 645 students in master's studies in KU Leuven's 16 faculties. The university has a total of 60 592 students, 16% of whom are from abroad.
Tailored to the model of the Ecole Polytechnique in France, the Faculty of Engineering Science (FES) opened in 1864, operating under the name 'Ecole des Mines et des Arts et Manufactures'. In 1961, it was officially recognised as an independent faculty of the Leuven University. The faculty took its current name in 2012.

In 2004, education was geared towards a three-year bachelor's and a two-year master's programme. In 2021, the FES was ranked 48th in the Times Higher Education university ranking, taking the 9th place in Europe. The faculty hosts 188 professors distributed across 7 departments. Enrolment in the Faculty of Engineering Science stands at approximately 4 900 among whom 24% are female (cf. general presentation during CTI's on-site visit). The university also has a Faculty of Science, a Faculty of Bio-engineering Science, a Faculty of Architecture and a Faculty of Engineering Technology. Alongside these faculties specialised in science and technology, the university also has faculties in the field of humanities and biomedical sciences.

Like other faculties at KU Leuven, the FES "autonomously develops its vision, mission and strategy which must be consistent with the KU Leuven global strategy" (KU Leuven's Self-Evaluation Report (SER), page 11). It comprises seven departments that are "responsible for research, managing their own human resources and having their own administrative staff" (SER page 10). Research is the backbone of the faculty. Teaching is a cross-cutting activity managed by Programme Committees chaired by a programme director who relies on the human and equipment resources provided by the departments.
The mission of the FES is to "educate high-quality engineers for the benefit of society" (SER page 8). The research-based education strategy in scientific and engineering-fundamentals is clearly emphasised, with a bottom-up approach to programme development. This approach is based on the skills of research teams and can lead to problems managing non-scientific and cross-cutting issues.

The FES policy plan for the period 2021-2024 is summarised in 10 points (SER page 9): to analyse programmes to ensure a high quality flow of students from secondary schools, to pursue implementation of a central quality-control system, to develop active forms of teaching, including teaching assistant training and professionalisation, to

develop “internationalisation@home” initiatives and a high-quality international recruitment policy, to promote excellence in research, to strengthen the diversity policy of the faculty in gender and socio-cultural backgrounds, to develop alumni cooperation and promote dissemination of scientific and technical knowledge to companies and society.

Programmes
This evaluation procedure applies to the following FES programmes, all delivered on the main campus of Leuven (Campus Arenberg in Heverlee):

- 2 bachelor’s programmes (180 ECTS credits): Bachelor of Engineering (1 330 students of whom 17% are female) and the Bachelor of Engineering: Architecture (315 students, of which 55% are female). The teaching language is Dutch;
- 12 master’s programmes (120 ECTS credits) with a total of 1 731 students (of whom 21% are female and 27 % are foreign students). All programmes (except architecture) have a full English variant. Depending on the programmes, some Dutch programmes accept up to 50% English courses. For some programmes, full Dutch teaching is required without the possibility to include English courses;
- 2 international programmes (Erasmus Mundus Master of Science in Nanoscience and nanotechnology and EIT-KIC Master’s in Energy);
- 6 Advanced Master’s programmes -"Master na Master" in Dutch (60 to 120 ECTS credits) with a total of 432 students (33% are female), offering specialisations for holders of Master of Engineering degrees and / or foreign students with a much broader profile (foreign students represent 55% of the enrolment).

Resources
There are recent facilities and ongoing building constructions which provide students with state-of-the-art facilities.

The FES is located on the Arenberg Campus within walking and biking distance from the city centre of Leuven. Although student housing is available on campus and in the city centre, Brussels is easily reached by train and some students commute every day. New buildings are under construction, and the facilities -including a library and common work rooms and Fab Labs- are available on campus, together with sports facilities. The dynamic energy devoted to the development of FES research and teaching is visible through the numerous new facilities which have been commissioned in the last 6 years: a new building for the Department of Electrical Engineering (2,700 m^2 of office space, an auditorium, two classrooms and new laboratories) and the Chem&Tech/NanoCentre (11 200 m^2 of research space for chemistry and chemical engineering and 6 800 m^2 for research facilities). In 2021, a large new building, called the Quadrivium, also opened its doors. It accommodates a large auditorium, several multifunctional seminar rooms, didactical lab spaces and large collaborative learning spaces. The most recent construction works involve the expansion of the Department of Mechanical Engineering (building of laboratory spaces).

In 2021, the FES employed approximately. 280 professors -mostly full-time, but also professionals and guest lecturers and part-time professors- as well as 188 full-time-equivalent staff members (including research-department staff) and approximately 1 340 teaching assistants, postdocs and PhD students.

Internal funding from the federal government or the government of Flanders, mainly for educational purposes, provides the financial resources of the faculty. This funding provides for full-time and part-time professors, a limited number of temporary teaching assistants and most of the administrative and technical staff costs. It currently does not cover all costs

associated with education. The equivalent of about 100 full-time teaching assistants are involved in teaching activities. They are typically PhD students funded through project-related funding for fundamental and basic research through competitive project proposal applications within the university, project-related government funding on a regional, federal and international level, such as European Union projects or project-related funding based on contract research with industry.
Moreover, equipment and research facilities, acquired through research funding, are made available for the educational programmes.

Changes to the institution
Education is driven by research, since professors and teaching assistants are researchers and all students have to work on a master's thesis. Changes concern the internationalisation of the teaching staff and the PhD students, which is an indicator of the international recognition of the FES excellence in research.
Internship and entrepreneurship is encouraged by the faculty, in order to educate versatile and adaptive engineers.
The health crisis of 2020-2021 enabled the faculty to develop hybrid teaching methods and to train the teaching staff in distance-teaching techniques.

III. Follow-up of previous CTI guidelines for improvement

For the Faculty of Engineering Science of KU Leuven:

Previous guidelines for improvement CTI's decision recommendation n° 2016/09-11	Evaluation by the expert panel
Draw on the work already carried out to prepare for the accreditation in order to establish the long-term culture of quality assurance within the faculty, with the involvement of all stakeholders.	**Implemented**
Define and implement a faculty-wide soft skills policy that is then adapted to each programme. Recruiting cross-disciplinary human resources responsible for this aspect could be a possibility.	**Implemented**
Take advantage of the university's geographical location and international reputation to develop an ambitious policy for the outbound mobility of its students and to attract the best foreign students. Efforts must be made to pool resources between the various departments with the help of the University.	**Implemented**
Improve ties with alumni to gather their opinions on their studies and to accurately monitor graduate employment and careers.	**Implemented**

For the bachelor's programmes of the Faculty of Engineering Science of KU Leuven:

Previous guidelines for improvement CTI's decision recommendation n° 2016/09-11	Evaluation by the expert panel
Bachelor of Engineering: Architecture Take into account problems related to heavy student workloads and low success rates, which could be interrelated.	**Under implementation**
Bachelor of Engineering: Architecture: Improve the position of the programme with respect to the architecture and civil engineering programmes	**Under implementation**
Bachelor of Engineering: Architecture: Define an action plan to promote the programme in secondary schools to deal with low recruitment numbers.	**Under implementation**
Bachelor of Engineering: Improve organisation of the programme for non-scientific aspects and increase the time spent on them.	**Implemented**
Bachelor of Engineering: Work to make the major/minor system more flexible and adapt it to changes to the range of Master's programmes.	**Implemented**

For the master's programmes of the Faculty of Engineering Science of KU Leuven:

Previous guidelines for improvement CTI's decision recommendation n° 2016/09-11	Evaluation by the expert panel
Master of Engineering: Architecture: Increase interaction between professionals involved in the programme and full-time research-focused teaching staff.	**To pursue**
Master of Engineering: Architecture: Give the Industrial Advisory Board a more active role and encourage ties with alumni.	**Under implementation**
Master of Engineering, Architecture: Promote international mobility and the exposure of students to a non-academic environment.	**Under implementation**
Master of Biomedical Engineering: Improve quality control for international recruitment.	**Implemented**
Master of Biomedical Engineering: Organise monitoring for graduate employment.	**Implemented**
Master of Engineering, Civil Engineering: Update the programmes for the two options to correlate with the expectations of the job market.	**Implemented**
Master of Engineering Civil Engineering: Organise more formal relations with stakeholders.	**Implemented**
Master of Engineering, Chemical Engineering: Raise student awareness about the needs and context of their future career Draw attention to dropping student numbers.	**To pursue**
Master of Engineering, Chemical Engineering: Formalise relations with alumni. Draw attention to the organisation of soft skills in the curriculum.	**Implemented**
Master of Engineering, Computer Science: Quickly develop a structured action plan for involving stakeholders and the Industrial Advisory Board in the development and implementation of a policy to expose students to a non-academic job environment.	**Implemented**
Master of Engineering, Computer Science: In general, open up specialisations to subjects that are not solely related to research.	**Implemented**
Master of Engineering, Electrical Engineering: Open the programme up more to stakeholders and society.	**Implemented**
Master of Engineering, Electrical Engineering: Open up the Industrial Advisory Board to people outside the alumni circle.	**Implemented**
Master of Engineering, Energy: Improve the preparation of international students online alongside what is done for Dutch-speaking students from other universities.	**Implemented**
Master of Engineering: Energy: Develop opportunities for students to obtain industry experience and be exposed to industrial issues.	**Implemented**
Master of Engineering in Materials Engineering: Draw attention to dropping student numbers.	**Under implementation**
Master of Engineering in Materials Engineering: Draw attention to the organisation of soft skills in the curriculum.	**Implemented**
Master of Engineering, Mechanical Engineering: Quickly establish an Industrial Advisory Board to formalise the participation of stakeholders in the programme.	**To pursue**
Master of Engineering, Mechanical Engineering: Work with stakeholders to define the programme's policy in terms of exposure to the non-academic job environment and international mobility (incoming and outgoing).	**Under implementation**
Master of Engineering, Mechanical Engineering: Improve quality control for international recruitment.	**Implemented**

Master of Engineering, Mathematical Engineering: Work to define outcomes for graduates that correlate better with professional expectations.	**Under implementation**
Master of Engineering, Mathematical Engineering: Raise student awareness about the needs and context of their future careers.	**Under implementation**
Decision no 2016/09-11 for the programme Master of Nanoscience, Nanotechnology and Nanoengineering: Analyse graduate employment (especially in the nanotechnologies sector)	**Under implementation**
Master of Nanoscience, Nanotechnology and Nanoengineering: Develop opportunities for students to acquire professional experience and be exposed to industrial problems. There is a lack of opportunities to acquire experience during the studies. The industrial experience and the exposure to industrial issues should be developed.	**To pursue**
Master of Nanoscience, Nanotechnology and Nanoengineering: Prepare to organise study programmes in nanotechnologies at the end of the Erasmus Mundus contract – develop outgoing mobility and intercultural activities.	**Under implementation**
Master of Engineering, Mobility and Supply Chain Engineering: Quickly establish an Industrial Advisory Board to formalise the participation of stakeholders in the programme.	**Implemented**
Master of Engineering, Mobility and Supply Chain Engineering: Work with stakeholders to define the programme's policy to establish a balance between scientific and non-scientific (soft) skills and to develop international mobility (incoming and outgoing).	**Implemented**
Master of Engineering, Mobility and Supply Chain Engineering: Develop a structured action plan to increase student numbers.	**Under implementation**

Conclusion

In the past 6 years, the FES has implemented, or started to implement, 85% of previous CTI guidelines for improvement. Concerning the general management of FES, all recommendations were followed. Concerning recommendations per programme, industrial advisory boards (IAB) have been created in almost all programmes, with the notable exception of Mechanical Engineering. Efforts have been made to strengthen ties with alumni, but they are not yet formalised. Efforts have been made to implement soft skills and internships in the programmes, especially with the Problem Solving and Design course, but they are still seen as elective or to be acquired after graduation. There have been strong incentives from the CTI and also from the strategic plan of the university to develop international relationships and exchanges and these actions need to be pursued.

The FES and the programme-management team did follow most of CTI guidelines for improvement. However, some efforts still need to be made on formalising interaction with industry (for example, by scheduling more regular meetings) and with the alumni community.

IV. Description, analysis and evaluation by the expert panel

Mission and organisation of the faculty

In 2020, a new dean was elected and the FES adopted an autonomous policy which must be consistent with the KU Leuven global strategy. The main lines of this strategic plan are developed over 5 areas: international development, future-oriented education based on active learning, going digital, interdisciplinary approach and sustainability. In the same way, the programme committees, which are in charge of implementing and developing programme content, have autonomy over their programmes, as long as they adhere to the framework set by the Faculty and the University.

The Faculty Programme Committee is responsible for the curricula as a whole and for the study programme of each individual student. It is the central unit for the programme and for quality assurance.

The daily operations of the FES are managed by 5 people: the Dean, the Vice-Dean for Education, the Vice-Dean for International Affairs, the Academic Secretary and the Administrative Director. Approximately 24 full-time-equivalent administrative staff assist them. They are the core members of the Faculty Board, together with the heads of the research departments. They are also in close interaction with the Faculty Programme Committee, chaired by the Vice-Dean of Education, which manages the individual programme committees. This organisation provides a good balance between research and education, makes it possible to pool equipment and infrastructure and to better manage costs.

Communication channels are diverse and adapted to each stakeholder. For example, teaching staff and students are represented in the Faculty Programme Committee, elected students are part of every official decision-making body of the university, and they can also submit an online student evaluation twice a year. However, not all courses are evaluated each semester, but at least once every three years. Concerning communication with industry and society, most programme committees have their own Industrial Advisory Board, where matching the specific programme with the needs of industry is discussed. Even if some efforts have been made towards alumni, ties are more informal.

In April 2022, the staff of the Faculty of Engineering Science consisted of:

- 162 full-time professors (assistant professors, associate professors, professors and full professors), of which 26% are female and 22% are not Belgian citizens;
- 16 tenure track assistant professors;
- 30 part-time professors, of which 23% are female and most of them combine a job in industry with involvement in courses;
- 77 guest lecturers, of which 22% are female;
- Approximately 24 full-time equivalent administrative staff members;
- There are also 1 343 teaching assistants, postdocs and PhD students and 189 full-time equivalent staff members, including research department staff.

The criteria for promoting faculty members are based on three criteria: research-related, education-related, and service-related criteria.
These numbers indicate that female professors are still largely underrepresented, even if improvement in this respect is envisaged in the future, and given the fact that the number of associate professors is more balanced. However, the trend towards internationalising the teaching staff is well under way: one-third of the tenure track professors are internationally recruited and about two-thirds of the associate professors have a non-Belgian nationality.

In order to teach courses in Dutch, a C1 language certificate in Dutch is required. For new tenure track professors, a B2-level certificate in Dutch before the end of their five-year tenure track period is expected. Likewise, taking up a course in the English programmes is subject to the requirement of holding a C1-level certificate in English.
The language requirements put an extra burden on Dutch-speaking professors, mainly with respect to teaching in the bachelor's programmes. The Flemish Higher Education Decree stipulates that only 18% of the credits (i.e. 32 credits out of 180 for a bachelor's programme) can be taught in a non-Dutch language. Initiatives are currently being developed to investigate whether such an international bachelor's can be organised in collaboration with UC Louvain.

Analysis summary - Mission and organisation

Strengths:

- Strong and constructive relationship between teaching and research;
- A sharing of best practices among faculty programmes;
- A strong administrative team to support activities of the faculty;
- Substantial financing from the university.

Weaknesses:

- Gender balance;
- Financial sustainability of some Advanced Master's programmes;
- The current legislation concerning language of courses leads to double teaching, which is not very efficient.

Risks:

- Satisfaction surveys on courses by students are not representative.

Opportunities:

- Development of a virtual teaching framework.

Quality and continuous improvement approach

Since the last CTI evaluation, following a decision by the Flemish government in 2019, universities are responsible for educational quality. The KU Leuven university developed the internal system “COBRA” to monitor quality management at three levels: university, faculty, programme.
The cycle for quality management is monitored by the Educational Quality Monitoring Unit, on behalf of the Vice-rector for Education Policy.
A bottom-up approach is implemented starting at the programme level. The Programme Committee develops the blueprint and the corresponding action plan, involving students, teachers, staff, and partners, to boost the engagement of people, and encourage self-criticism and involvement in continuous improvement.
To help the self-reflection and evaluation of the quality culture of the Programme Committee, the central education quality team proposed a maturity matrix; the review of this matrix could lead to the proposal of specific courses to the Programme Committee members.
Education quality is monitored through periodic assessments, every 2 years at the programme level, handled by the Programme Committee at faculty level, and every six years at the university level. However, some topics can be reviewed more often.
Research quality is handled by an external Research Advisory Board. Participants are international researchers. A specific dashboard is published and reviewed every 4 years.
Quality documentation is also monitored: all internal regulations documents, procedures with respect to education, research, legal aspects, staff, ICT, finances are available on the website in Dutch and in English, along with a “code of conduct”. One document defines the retention and archiving policy of the different documents.
The CTI evaluation team could assess that the persons concerned are aware of the documents relevant to their activities.
The quality of alumni surveys needs to be checked every 2 years. The data provided were not available for all master’s programmes, and if available, the last reference date is 2018, with too low a response rate (average 25 %).
The course evaluation is organised on a yearly basis at the university level with an online questionnaire. The Programme Committee decides on the courses that will be evaluated each year. Each course is evaluated at least once every three years; if a new teacher takes on a course, the course will be evaluated in the current year.

In conclusion, quality is embedded in the management of the faculty. All relevant documents and dashboards are available on the internal document repository. Transparency is the rule since every document can be viewed by other internal stakeholders. The CTI expert panel could assess this. This leads to an efficient system of self-evaluating the quality of study programmes on the basis of continuous improvement at the proper level. The faculty could improve their evaluation process to motivate students, and get formal feedback, even through informal and frequent discussions between student and teaching staff.

Analysis summary - Quality and continuous improvement approach

Strengths:

- Quality management policy handled by the faculty;
- Continuous improvement approach monitored at the programme level with support of the faculty and the university;
- Transparency on the quality follow-up.

Weaknesses:

- Response rate for surveys

Risks:

- N/A.

Opportunities:

- N/A.

Outreach and partnerships

In most programmes, representatives from companies or research institutions are part of the part-time teaching staff; this is particularly the case in architectural engineering. The percentage of their teaching time can be very different from one person to another.
Companies often propose the projects or subjects for dissertation theses offered to students as well. They can be supervised by a teacher from the university and tutored by a person from the company.
Executive representatives from companies are also very present in the Faculty Senate at the faculty level, and at the programme level as well. In all programmes but one, there is an Industrial Advisory Board. However, the meeting frequency depends highly on the programme: from twice a year to every second year.
The importance of the Alumni Association (AIKUL) has increased, and the faculty now supports a part-time staff member to streamline communication.
The Vlaamse Technische Kring (VTK) also contributes to ties with industry by organising job fairs.
As stated in the SER, the "KU Leuven is a research-intensive university". The faculty teaching staff are members of 7 departments and are very active and recognised in their own fields. The extent of the research activities can be described not only by the number of PhD students (1 173), of whom approximately 160 defend their doctoral thesis every year, but also by the very high publication output and the acquired research budget from external funding. Faculty members are also recipients of competitive research grants (22 European Research Council Grants since 2016).
There is a specific technology transfer office, called Leuven Research & Development.
Over the years, the FES has been at the root of the creation of about 80 spin-off companies out of a total of 142 for the university as a whole. Students can take some courses and/or projects on entrepreneurship, such as 'Engineering & Entrepreneurship' (6 European Credits (ECTS), at master's level, taught in English) and 'Entrepreneurship in practice / Service learning' (6 ECTS, at master's Level, taught in Dutch).
There has been a steady increase in the number of foreign students over the last 6 years. Enrolment data for 2020-21 are presented in the table:

programmes	Belgian students	EU students (%)	Non-EU students (%)	Total
Bachelor's	1 534	24 (1,5%)	10 (0,6%)	1 568
Master's	1 262	154 (8,8%)	315 (18%)	1 731
Advanced Master's	193	86 (20%)	153 (35%)	432

The Faculty of Engineering Science currently has 130 co-operation agreements with foreign universities.
It is an active member of 7 networks. For student exchanges, especially outgoing mobility, one of the most active networks is the ATHENS Network, uniting 15 European technological universities or institutions. It aims at facilitating the exchange of students, professors and researchers.
Faculty staff are closely involved with the following research centres: IMEC (microelectronics), VITO (environmental), Flanders Make and SIM (Materials) which are very important organisations in Belgium.
The faculty has plans for a bachelor's programme in English taught with Université Catholique de Louvain, which seems a very good initiative to the members of the expert panel.

The faculty and university have ties with VUB and UGent because they have joint programmes.

Analysis summary - Outreach and Partnerships

Strengths:

- Industrial Advisory Boards exist in most programmes;
- Students have many opportunities to discover companies (internships, master's thesis, part time teachers);
- Projects with UCLouvain;
- University technology transfer centre.

Weaknesses:

- N/A.

Risks:

- Political rules that could prevent the bachelor's programmes taught in English.

Opportunities:

- The Industrial Advisory Board should meet at least once a year.

Educational process regarding all programmes

The courses at the FES are divided in two cycles:
The Bachelor of engineering programme (180 ECTS) is designed to provide students with a strong scientific background as well as a first orientation towards two of the engineering disciplines developed in the KU Leuven masters' programmes. It is therefore designed as the first 3-year part of a full 5-year master's programme.
Following this cycle, students can enter the master's programme (120 ECTS), where they specialise in a specific field. After obtaining a master's degree, they can also join an advanced master's programme (60, 90 or 120 ECTS). The choice of options (major / minor) in the third year of the bachelor's determines the master's programme that can be taken as soon as the bachelor's degree is obtained.
Programme Committees at the bachelor's and master's level manage the course of studies. The Faculty Programme Committee coordinates their actions. Students are involved in the process of designing and updating the study programmes via their participation in all official faculty committees.

Curricula and educational objectives are publicly available on the university's website. The website contains all information needed for potential students. For each master's programme, the outline, admission requirements, learning outcomes and career opportunities are clearly described. Comprehensive course descriptions (with number of credits, learning outcomes, prerequisites, content of the courses, information on the assessment, etc.) are also available online.
Each semester is identified and contains 30 ECTS credits.

Professors introduce key findings and current trends in research in their courses at the bachelor's (final year) and master's levels. PhD students are engaged in teaching activities. All Master of Engineering programmes include in their last semester a master's thesis, for which students are awarded 24 ECTS credits. Subjects offered in this course are highly geared towards research. Some courses also have direct ties with research activities. The master's thesis experimental work is conducted in a research laboratory of the faculty; students have access to state-of-the art research facilities and they can use research equipment (under supervision). Some of the best work done in master's theses is published in peer-reviewed journals. It is to be noted that in some departments, laboratory work and projects are done where research is taking place.

The Problem Solving & Design activities develop some skills in innovation. Three courses have been set up to address the topic of entrepreneurship:

- at the bachelor's level, the mandatory course Industrial Management & Entrepreneurship introduces the principles of enterprise management (6 credits);
- at the master's level, the optional course Engineering & Entrepreneurship discusses topics related to strategic management and creativity and decision-making for product development (6 credits);
- the Technology & Entrepreneurship case studies present testimonies on the role of engineering within the start-up of technological spin-offs;
- the elective course Entrepreneurship in Practice is an entrepreneurial project which can last from one semester to one year and is offered to individuals or teams, depending on the project (3 to 6 credits). Registration in this course is subject to acceptance of the application by the course coordinator.

The bachelor's programmes are taught in Dutch. Therefore, they do not particularly create an international context. The required C1 level in Dutch to teach in these programmes makes it difficult for international professors to get involved. This is quite different at the master's and advanced master's levels, where strong internationalisation of the student population is observed.

Issues of sustainable development and social responsibility in the master's programme concern 20 courses.

Face-to-face teaching represents 25 to 30 hours per week. The Problem Solving & Design activities develop soft skills, such as communication, writing skills and the ability to work in a team.
The health crisis in 2020-2021 was an opportunity to introduce new teaching methods, mostly hybrid learning. However, blended learning and flipped teaching are used in several courses.
Teachers were trained on learning outcomes (2-day training) in order to improve the link between courses and skills.

The spectrum of student life is very broad, ranging from student services (tutorial services, printing and selling courses at very low prices, offering places to eat or relax, etc.) to organising student activities and events (1 to 2 events per day) or professional events (conferences, professional gatherings, etc.).
There is an active student life at the faculty and at KU Leuven in general. VTK (the Faculty of Engineering Science student union) has over 3 000 free affiliated members. The core group of VTK consists of 68 elected students. VTK defends the interests of the engineering students at the university, city and national levels and manages most of the activities offered to students. The spectrum of activities offered is very broad, ranging from student services to organising student activities and events or professional events.
These include (but are not limited to): Programme-committee participation, the Faculty Council, the Faculty Board, but also all public relations-related meetings, all sorts of task forces (diversity & inclusion, internships, etc.).
VTK connects first-year students with older engineering students who volunteer and will mentor them throughout the first year.
VTK is in charge of the physical distribution of most of the textbooks, printing slides, handouts, etc. through their own bookstore in close collaboration with the lecturers. VTK also organises the Job Fair, which is the largest job fair for engineers in the Benelux region.

A student positioning test (mandatory since 2018) is aimed at detecting students with potential difficulties. It is followed by remedial courses when needed. A second test is taken 4 weeks later. It was observed that 70 % of the students with a score under 10 dropped out.
The general student dropout rate remains high (40 %), despite fine tutoring services.
A Summer School is offered to students before the bachelor's programme starts. More and more students are opting to join it.
Students have a heavy workload (around 50 hours a week). The tutoring services help them handle it. Around 200 students were using it in 2021-22. The VTK student union is involved in this tutoring service by organising so-called PAL-sessions for certain courses (Peer Assisted Learning). Around 40 tutors work with groups of 4 to 5 students. A university-wide service (KU Leuven Stuvo) provides online modules, workshops and training.
A first milestone was introduced (the first phase of the programme is separated from the others): this helps in detecting difficulties and reducing the average time needed to obtain the degree. Students will be advised on possible reorientations when needed.
The Educational Committee handles each semester evaluation. Urgent situations can be handled. Tutoring services talk to students (1 per sub-group of 16) twice in the semester.

Students showed a very positive appreciation of the Committee: it deals with general issues as well as smaller aspects or concerns. Issues are brought forward by student representatives and are generally well received by teachers. The atmosphere is nice and the head of the Committee is very involved with students. The Committee usually aims at a consensus when a decision is to be made.

Evaluation methods are described. Students are aware of their current position (dashboard system). Attention should be paid to better feedback on evaluations. In this regard, systematisation and exchanges of good practices among the teaching staff should be put in place.

Analysis summary – Educational process

Strengths:

- Strong desire to improve teaching methods and learning outcomes;
- Student support (tutoring services) and management of teaching monitoring bodies;
- Problem Solving & Design activities;
- Possibilities offered by the major/minor combination system.

Areas for improvement:

- The links between the different courses could be improved;
- Some master's programmes appear to recruit less students and could therefore be made more visible to bachelor's students.

Risks:

- Heavy workload for students and high current dropout rate;
- Heavy workload on Dutch-speaking teaching assistants;
- Complexity in the programme structure resulting from the major/minor combination system.

Opportunities:

- Use the programme reform to integrate more cross-cutting concepts (such as sustainability);
- The possibility of a joint bachelor's taught in English is currently being discussed and could help in developing an international culture in the programme.

Educational process regarding the different programmes

Bachelor of Engineering

The Bachelor of Engineering programme is designed to prepare students and help them in their choice of a master's programme. It provides a strong scientific background as well as a first orientation towards two of the engineering disciplines developed in the KUL master's programmes. It is therefore designed as the first 3-year part of a full 5-year master's programme.
The programme is divided into two parts (B1 and B2) of 3 semesters each. B1 is common to all students and offers basic science courses, introductory courses to engineering sciences as well as a general interest course (economics). In B2, students choose 1 major (out of 7) and 1 minor (out of 9). 35 major/minor combinations are offered. Although these combination possibilities are appreciated by students, this system complicates the programme structure. A programme reform (the possibilities of which are currently under investigation) will aim at simplifying this system (amongst other goals).

In 2020-21, 1 330 students were preparing for the Bachelor of Engineering (496 students in B1). Among them, 1 296 were Belgian, 24 came from EU countries and 10 from non-EU countries. Only 17% of the students were women: actions to increase this percentage have yet to be successful.
59 teachers (including 14 women) teach in B1; 108 (including 28 women) in the majors and 24 (including 5 women) in the minors. Around 180 teaching assistants and student assistants (monitoring) are spread over the 3 years of this programme.

A Programme Committee manages the B1 part. The B2 part is managed by the master's Programme Committees (corresponding to the major and minor chosen) and coordinated by the Faculty Programme Committee.
The combination of a major and a minor offers more choices to the Bachelor of Engineering graduates when selecting a master's and prepares them for the multidisciplinary approach of the master's programmes at KU Leuven. The Individual Study Programme (ISP) enables students to later adjust their curriculum in case the selected master's programme does not fully match their major/minor combination in the bachelor's.
In spite of the previous recommendation regarding the little room left for non-scientific courses, the programme has kept a strong engineering foundation: the non-scientific courses add up to 12 credits distributed over 3 courses, which represent 7% of the 180 credits awarded in the bachelor's programme. Master's programmes generally include an additional 9 to 12 ECTS credits worth of non-scientific courses. The envisaged reform of the bachelor's programme should take this aspect into account.

Curriculum: programme outcomes and learning outcomes

A table describing all 6 semesters was included in the self-evaluation report (SER).
B1 contains general and applied science courses (such as general engineering chemistry, engineering mathematics, analysis, general physics, electrical circuits, etc.).
An interesting feature of this programme is the Problem Solving & Design course, a practical way of mastering skills in various engineering disciplines, as well as specific skills such as the ability to work in a team. This type of teaching is offered in 5 out of the 6 semesters and totals 20 ECTS credits.
In B2, each major contains 48 credits (39 credits of discipline-specific technology courses and 9 credits of Problem Solving & Design) and each minor contains 33 credits.
A matrix (available in the annexes of the SER) describes how each course meets a number of programme outcomes (evaluation and/or coverage of a given outcome).

Each semester is identified and contains between 29 and 31 ECTS credits. All courses are associated with a given number of credits.
A detailed description of each course is available online (https://onderwijsaanbod.kuleuven.be/2021/opleidingen/e/CQ_51601481.htm#activetab=diploma_omschrijving – *consulted in May 2022*), including the course objectives and content, the type of teaching applied, the learning outcomes, the course material and the type of evaluation.

Programme implementation
The regulations on education and examinations are approved by the Academic Council with the complementary and deviating regulations of the Faculty of Engineering Science.

Research activities, innovation and entrepreneurship training
The Problem Solving & Design activities develop some skills in innovation. The B2 contains an Industrial Management and Entrepreneurship course (6 ECTS credits).

Training for an international multicultural context
As it is taught in Dutch, the Bachelor of Engineering does not particularly create an international context. The required C1 level in Dutch to teach in this programme makes it difficult for international professors to get involved.

Sustainable development, social responsibility and ethics
The Bachelor's programme does not tackle sustainability specifically, but 20 courses are concerned in the master's programme. The programme reform could help in implementing sustainability issues in the teaching activities.

Educational engineering
Face-to-face teaching represents 25 to 30 hours per week. The Problem Solving & Design activities condense soft skills: they develop communication and writing skills among students. They also involve teamwork and allow the integration of disciplines. This latter aspect could be more developed since it brings additional sense to students when studying a given discipline.
The pandemic was an opportunity to introduce new teaching methods, but they were mostly hybrid learning. However, blended learning (especially in B1) and flipped teaching are used in several courses of this programme. Students mention that "they learn to think in different ways".
Teachers are trained on learning outcomes (2-day training) in order to improve the link between courses and skills.

Student life
The VTK student union manages most of the activities organised for students. The spectrum is very broad, ranging from student services (tutoring services, printing and selling courses at very low prices, offering places to eat or relax, etc.) to organising student activities and events (1 to 2 events per day) or professional events (conferences, professional gatherings, etc.).

Student monitoring / failure management
A student positioning test, mandatory since 2018, is aimed at detecting students with potential difficulties. It is followed by remedial courses when needed. A second test is taken 4 weeks into the academic year. It was observed that 70% of the students with a score under 10 dropped out. The student dropout rate remains high (40%), despite fine tutoring services.
A summer school on mathematics is offered to students before the bachelor's programme starts. More and more students are choosing to join it.

The workload is heavy for students (around 50 hours a week). The tutoring services help them handle it. Around 200 students were using it in 2021-22. The VTK student union is involved in this tutoring service as well, by organising peer-assisted learning activities. Around 40 tutors work with groups of 4 to 5 students. An additional university service (KU Leuven Stuvo) provides online modules, workshops and training.
A first milestone was introduced (the first phase of the programme is separated from the others): this helps in detecting difficulties and reducing the average time needed to obtain the degree. Students will be advised on possible reorientations when needed.
The Programme Committee and tutoring services handle each semester evaluation. Urgent situations can be handled. Tutoring services talk to students (1 per sub group of 16) twice in the semester. Students showed a very positive appreciation of the Committee: it deals with general issues as well as smaller aspects or concerns. Issues are brought forward by student representatives and are generally well received by teachers. The atmosphere is nice and the head of the Committee is very involved with students. The Committee usually aims at a consensus when a decision is to be made.

Assessment of results
Evaluation methods are described. Students are aware of their current position (dashboard system).

Analysis summary – Bachelor of Engineering

Strengths:
- Strong desire to improve teaching methods and learning outcomes;
- Student support (tutoring services) and management of teaching monitoring bodies;
- Problem Solving & Design activities;
- Possibilities offered by the major/minor combination system.

Weaknesses:
- The links between the different courses could be improved;
- Some master's programmes appear to recruit less students and could therefore be made more visible to bachelor's students.

Risks:
- Heavy workload for students and high current dropout rate;
- Heavy workload on Dutch-speaking teaching assistants;
- Complexity in the programme structure resulting from the major/minor combination system.

Opportunities:
- Use the programme reform to integrate more cross-cutting concepts (such as sustainability);
- The possibility of a joint bachelor's taught in English is currently being explored and could help in developing an international culture in the programme.

Bachelor of Engineering: Architecture

Architecture has a specific position in KU Leuven as there is a specific and explicit bachelor's programme. However, in comparison with other universities, architecture is not explicitly mentioned in the name of the faculty: Faculty of Engineering Science.
This bachelor's programme is organised to provide bachelor's students with a balanced education between technical sciences, architectural sciences and design.
A reinforcement in Analysis and General Physics has been implemented in order to provide the students with a stronger scientific basis and avoid too many dropouts (which is confirmed by statistics). The introduction of a 3 ECTS course on Mathematical Basics and Spatial Awareness has also been considered as needed for all the bachelor's engineering programmes. These lectures are given as "anchor" courses and are common with the students from the general Bachelor of Engineering.

The programme is defined and monitored by the Programme Committee. Fundamental courses decrease while specific lectures in architecture and design increase from semester 1 to 6. Design studio teachers include 17 part-time and 2 full professors. Integration of full-time architectural science professors in the design studio should be increased but teaching overload and scientific production requirements are limiting this collaboration. Regular meetings between teachers from design studios and full-time teachers are organised separately. A representative of the full-time teachers attends the meetings of the studio teachers; a representative of the studio teachers attends the Programme Committee meetings. There are seldom meetings with all the teachers.

A very specific characteristic for the KU Leuven Bachelor of Engineering: Architecture is that the engineering part of the programme is very strong, and therefore produces engineers specialised in architecture. Collaboration and incorporation of teachers from architecture firms into the academic staff seems to be efficient for continuously adapting the programme. Students are usually involved in discussions and appreciate the good contacts with academic staff.

Curriculum: programme outcomes and learning outcomes

The programme aim is to train graduates that are experts in the built environment, or in design and construction. The programme is considered as a part of the programme of the Bachelor of Engineering, with a specific focus on design and humanities.
However, social sciences fields such as economy or sociology are only slightly developed in the curriculum. Visibility of sustainable development and architecture is poor and doesn't seem to be pointed out. However, it seems that the Industrial Advisory Board does not consider this situation as one "of major concern". Internships are not considered at this stage.
Teamwork is performed in design studios where students work in small and large groups.
The programme globally consists of 56% technical sciences, 17% architectural sciences and 27% design. A comparative analysis of the programmes in terms of the proportions between core subjects, engineering sciences and architecture was carried out with the two other Flemish universities offering the same training: the programme is considered by the programme coordinators as highly oriented towards architectural engineering.

Programme implementation

There is no admission selection, as long as the secondary school diploma has been obtained. This can be considered as a disadvantage because it can cause high dropout rates. Recruitment at the BA1 level has been relatively stable in the last 6 years (91 newly enrolled students in 2020-2021). Students entering studies in the Bachelor of Engineering (including architecture) are required to take a positioning test. It has been mandatory since

2018 but the outcome of this test is not binding. A reduction of 1 ECTS credit (Mathematical Basics and Spatial Awards course) is offered if they pass the test.

There is generally a good gender balance, with a slight advantage for female students.

Design studios are evenly distributed over the 6 semesters of the bachelor's programme. These projects, based on "real topics", are managed by a team of 17 part-time professors.

Research activities
Many professors perform research and share their updated knowledge with students through their lectures.

Training for an international multicultural context
As the programme is taught in Dutch, no international exchanges are set up (incoming or outgoing).

Sustainable development, social responsibility and ethics
Even if the topics are considered in Design Studio, the theme does not clearly appear in the programme.

Educational engineering
Projects, studio and group activities help the students to become independent and responsible. They are regularly evaluated.

Student monitoring / failure management / assessment of results
The students are well monitored and helped by the university. The only post-graduate option is the master's curriculum in engineering: architecture. The analysis of at the time to complete a bachelor's degree shows that only 50% of the students succeed after 3 years and 75% after 4 years. The percentage of new students who succeeded for all courses remains stable and relatively low around 25%. Anchor courses seem to have an effect in decreasing dropout numbers but this needs to be confirmed.

Analysis summary – Bachelor of Engineering: Architecture

Strengths:

- Connection between architecture and engineering: a choice for an engineering approach to architecture;
- Good balance between courses throughout the 3 years;
- Official evaluation of courses at least every 3 years. Informal evaluation throughout the year;
- High quality of the contact between students/teachers;
- Follow up of site work and reporting;
- Very comfortable level of supervision rate. Good gender balance among teachers;
- Study guidance well organised;
- Recommendations followed.

Weaknesses:

- Lack of visibility of sustainability. Need for theory on sustainability;
- Training in soft skills: communication, ethics;
- Low success rate in 3 years - increase in the actual duration of the studies (from 3 to 4 years).

Risks:

- The dropout rate even after “anchor” courses seems to be just slightly higher than the rates in the Bachelor of Engineering;
- Lack of visibility compared to the Faculty of Architecture;
- Decreasing number of students;
- Workload too heavy / not enough credits corresponding to the workload in design studio;
- Diversity of profiles due to the recruitment (orientation tests).

Opportunities:

- Reform of the bachelor’s degree at the faculty level (including mathematics) will affect the Bachelor of Engineering: Architecture;
- Collaboration with the faculty/department of architecture, including courses from the master’s level;
- Better integration of full-time professors in design studios.

Master of Engineering: Architecture

The aim of this multidisciplinary programme (120 credits, 2 years) is to train experts in the built environment or in design and construction, able to adapt to unpredictable changes in society. What is aimed for by the staff is an engineering approach to architecture focusing on design, with less engineering courses than in the other engineering programmes but reaching the same level. (The courses on building technology are taught together with the Master of Engineering: Civil Engineering).

The mandatory core consists of 53 credits and 3 options (Architectural Design, Engineering Design and Urban Project), this allows students to differentiate their curriculum. However, the specific character of the urban design option is clearer than the difference between the architectural and technical design options. Each option includes 18 credits for design projects. In addition to these core courses, the master’s thesis (24 ECTS credits) helps to orient the curriculum of students more specifically. It can be research or design-based, making the design component vary from 15% to 35% of the whole curriculum.
Elective courses vary from 13 to 16 ECTS credits depending on the option.

In 2021-2022, the programme enrolled 136 students of which 86 were female. As the programme is mostly taught in Dutch, 135 students were Belgian nationals. The number of students has decreased since the last CTI evaluation. Most of them come from the Bachelor of Engineering: Architecture of KU Leuven, there are few parallel entrances.
The number of graduates varies between 60 and 65 each year.

There has been a generational shift in the staff very recently: 8 professors who belong to the department of Architecture teach in the programme, but they are helped by 5 professors of the Department of Civil Engineering and by 4 from other departments (in total 6 women, 11 men). The studios are taught by 15 part-time teachers, mostly architects, and by 2 full-time professors. Since the last evaluation, the number of full-time professors teaching studios has progressed but could increase further.

The programme has evolved since the 2017-2018 academic year to include the same number of credits for design studios in the 3 options.

The Academic Skills and Quality Assurance framework was mapped in 2014-2015 and is being renewed (completion is expected before September 2022).
There is an Industrial Advisory Board but it does not meet often enough. More frequent meetings could help the development of the programme.
Each year a one or two-day seminar is organised for all the staff on the learning outcomes of the studios and this is an important meeting for the programme.
For now, courses on History of Architecture or on Building Information Modelling (BIM) have not been integrated into the design studio. The integration of these two courses could be discussed further.

Curriculum: **programme and learning outcomes**
Overall, the consistency with expected learning outcomes is good, but there seems to be a significant scale difference between the urban and architectural/technical project on social relevance and the interaction with stakeholders.
The curriculum is clear, however the staff must remain attentive to potential work overload of students. It seems that discussions between staff and students take place very easily when this kind of problem occurs. The syllabus is available to students.

Programme implementation
The Job Fair, organised by the VTK student union, gives students a good overview of their future job. Moreover, the part-time teachers in studio projects also allow many discussions with students on this subject. A second summer internship will soon be added to the programme (as an elective course), because students want to spend more time in internships. The elective modules allow some kind of personalisation of the student's study trajectory.

Research activities, innovation and entrepreneurship training
There is a research tradition in this master's, boosted by the arrival of new professors. The master's thesis is closely connected to ongoing research. A master's thesis market is organised with a presentation of the subject in one page (the pitch being abandoned) and 90% of the students obtain their first choice.
However, the space available for studios is a bit small, plans for development in a new building (Alma 3) seems to be a good opportunity for the future.
As regards innovation and entrepreneurship, there are electives available for those who are interested, however it is not very popular in this discipline.

Training for an international multicultural context
Each year, 30 incoming Erasmus + students follow a personalised programme while outgoing mobility fluctuates between 10 and 20 Erasmus + students. In addition, some students take ATHENS courses abroad. This makes this programme a "role model in the faculty". There could be more intercultural exchanges developing links with advanced master's students, for example in projects.

Sustainable development, social responsibility and ethics
Sustainability is incorporated into many courses but it is not visible enough. Teachers should make an effort to name and describe these topics. For example, a study on environmental impact could easily be added to project reports or theses. Making place for sustainability in the programme is one of the subjects discussed in the Programme Committee.
Ethics should also be developed, plans to transform the mandatory course on religion to a course/project in ethics seems like a very good idea.

Educational engineering
The design studios use analogue as well as digital media. During the COVID sanitary crisis, many online activities were developed. The faculty must now decide on the future of activities that have already been implemented. Currently, lecturers are experimenting with various formats for online and hybrid practice and design sessions. A balance between distance learning and face-to-face learning needs to be found.
The composition of groups for projects is imposed on students, which is good preparation for future teamwork.
Construction site visits are being added to the programme, these visits are prepared and lead to questions and reports from the students.
This programme is oriented towards design. In this field, projects are sustained by theoretical courses, which ultimately leads to a good balance, appreciated by the students.
Part-time teachers introduce different views, which is a very rich experience for students.
Projects are led on an individual or team basis.
There is group work and individual work.

Student life
Each year, first year master's students organise "Existenz", a week based on architecture-related projects. Teachers strongly support this initiative, both financially and educationally.
The job fair organised by the VTK student union also motivates all students. It includes lectures on deontology and practices.
Each year the Maarten Bouwen prize encourages students on their master's thesis. It is also a good communication tool for the programme.
Students of this master's should be encouraged to exchange more with students from the advanced master's programmes.

Student monitoring / failure management / assessment of results
The progression rate is in line with the progression rate in other master's programmes, it has improved since 2015. It was 71% in 2019.
The student guidance service is used by students and appreciated, as well as the yearly hearings that the Programme Committee organises for fast feedback.
Graduates are hired in a range of jobs, some becoming architect designers, and others engineers or consultants.

Analysis summary – Master of Architecture

Strengths
- Interdisciplinary aspects;
- 3 options that are well balanced and that can be chosen freely by students;
- The "Existenz" week, organised by students and supported by teachers;
- The Urbanism option is organised in connection with the advanced master's, which is a source of enrichment for all students;
- Maarten Bouwen prize for the master's thesis is a good communication tool for the programme;
- Yearbook "Launch" and end of the year exhibition are good communication tools;
- Long list of topics for the master's dissertation in connection with research;
- Good representation of students in the councils and associations.

Weaknesses

- Sustainability is too implicit;
- The Industrial Advisory Board should meet on a more regular basis;
- Lack of space in the Castle to develop the studios;
- The Fablab is distant and shared with other programmes which increases deadlines;
- Not enough full-time teachers taking part in studios;
- There is a lack of specific of options and especially between the architectural and technical design ones;
- There is an important scale difference between the urban and architectural/technical project: social relevance, interaction with stakeholders.

Opportunity

- The “Alma 3” building will be a good improvement of infrastructure for the studios;
- The teaching staff participates in the plans to renovate the whole campus;
- Composition of group work teams for projects are imposed on students;
- Transformation of course on religion into ethics courses;
- It would be a real opportunity for the master’s students who organise EXISTENZ to reach out to their fellow students of the advanced master’s degree.

Risk

- N/A.

Advanced Master of Human Settlements - post-master’s

This programme is organised by the International Centre of Urbanism, Settlements and Environments, which is well known around the world and makes the programme unique in its field. The programme was first dedicated to developing countries, then it dealt with major crises, through rapid urbanisation in the world and contemporary urban transformations. This is a 60 credit programme (one year) that can be taken after a 4 or 5-year programme depending on the origin of students. On average, 32 new students enrol each year. Students can have very diverse backgrounds, ranging from technical expertise to engineering, or to more social sciences. This diversity it what makes this programme so rich, allowing for multidisciplinary projects. The professional experience of many of the students is also very diverse. This contributes to the development of a critical and interpretive approach.
This is a true international programme because of its recruitment (Sub-Saharan Africa, Latin America, Palestine and Asia) and because of its staff’s expertise in worldwide research.

In 2020-2021, there were 25 women students and 13 men, 76% of whom were international students. This percentage fluctuates and can reach 97%.

There are 5 professors for mandatory courses (design or studios) and the staff includes teaching assistants (PhD students) in a rotating system: this is quite few for the number of students. In a few years, there will be a retirement wave among the staff supporting the programme.

The programme is accredited with ICP connect, which develops international study programmes organised at one or more Flemish universities. It has partners allowing both scholarships (12 are given by VLIR, the Flemish Interuniversity Council) and co-teaching in the programme. As a result, regional hubs have developed. Partners are from Vietnam, South Africa, Ecuador, Kenya, Mozambique and Palestine.

If the student and the faculty agree, the student can qualify for the second year of the Master of Urbanism Landscape and Planning after this programme, depending on his/her personal project. As the programme provides insights into the challenges and opportunities of worldwide settlements, it is devoted to adapting in this area of rapid changes. It has been the case concerning the crisis of the Vesdre Valley.

The programme began being reformed in 2018, taking effect in 2019-2020 to focus more on design studios and to better distinguish it from the programme in Urbanism, Landscape and Planning.
The recommendations of CTI included communication which has been largely developed by adding social media and which is completed by the work of the alumni network.
The core subjects are architecture, urbanism, landscape architecture and spatial planning but economics, geography and anthropology also prepare students to understand the interplay of human and natural ecosystems.
The programme includes design research or written thesis but also design studios and study trips. Workshops and design studios are very flexible to respond to the current crisis.
Through the ICP Connect partner collaboration, there have been many developments in design studios and world urbanism seminars, and the landscape architecture perspective has been developed positively.
The staff meets every two weeks in order to stay abreast of how the programme is being run and fine tune studios and courses.

Curriculum: programme outcomes and learning outcomes
The programme provides students with the capacity to work independently and critically, and to contribute significantly to sustainable development by applying context-responsive approaches.
It seems that giving more knowledge on digital issues (other than with an elective course) could help students for the job they have to do during their studies. This could be an area for improvement.
Even if a post-master's is not part of the Bologna process, courses are described in semesters and have a corresponding amount of ECTS credits. Compulsory courses count for 16 ECTS credits, optional courses are 46 ECTS credits, design studios are 15 ECTS credits and the master's thesis is 15 ECTS credits.

Programme implementation
The variety of experiences during the programme provide good preparation for the future of the graduates. There is a good mix of students having already worked with classical students which boosts all of them on in this area, making them discover new horizons.
Students really work together but do not cooperate enough with the students in the initial Master of Engineering: Architecture.
In the current academic year, cooperation between the master's programmes was conducted with a workshop in the Vesdre Valley. This cooperation should be pursued for the benefit of all.

Research activities
This programme is closely linked to research. The outcomes of this research is more communicated outside the programme than previously, for example through the yearly World Urbanism Seminar and webinars.
The programme has organised very attractive events to promote and highlight the research work of its students.
The core of this research is the central role given to space as a resource and as a medium of integration which are very current concerns.
Several students continue on to PhD studies.

Training for an international multicultural context
Admission into the programme is based on the review by the programme director of a resume, application letter and a portfolio. A sufficient knowledge of English is also required. There are no prerequisites when it comes to digital skills, such as drawing programmes, etc. Perhaps useful knowledge information should be given to future students in order to increase their success rate.

Sustainable development, social responsibility and ethics
Sustainability is at the centre of the programme. It is embedded in most courses and in the objective of the programme.

Educational Engineering
The COVID sanitary crisis has had the effect of developing distance tasks and their supervision. It is now necessary to implement this blended learning to allow for more teaching from worldwide specialists. The programme presents a good mix of practice, projects, theoretical teaching, conferences and discovery trips.

Student life
Students find that it is easy to live in Leuven, even if they do not speak Dutch, since Leuven is a university town. This point should be taken more into account by the faculty. Since the start of the 2021-2022 academic year, there has been a housing service operated by the university which helps students find accommodation. Moreover, KU Leuven is investing in extra student housing, both within as well as outside of Leuven. However, some of the students have difficulties in finding their accommodation.
For now, there are currently 10 grants awarded from the Flemish Academic Council. This financing is not permanent, and as it is not an initial master's, the programme is not financed by the university. The fees are €3,300 per semester, which is rather high without a grant but not so high in comparison to other post-graduate programmes in England or the Netherlands. In addition, there is a partial tuition waiver given to students from the lowest income countries on the OECD list.
The programme should try to find financing from other sources, the support of stakeholders is currently mostly in natura.

Student monitoring / failure management
Because of the small size of the programme, students find they are well guided even if the student feedback to the Committee seemed not sufficiently formalised.
There is a broad and strong alumni network that organises events.

Assessment of results
The majority of students finish their degree within the expected timeframe of 12 months (99 graduates, which was 56% in 2021). In the last 5 years, only one student has not managed to get the degree. In this programme, many students have already had a job and their relationship with studies is different from the initial master's students.
Over the past 5 years, 17 graduates went on to the Master of Urbanism Landscape and Planning, and another small group of students started a PhD.
Graduates entering the job market work in the public sector, academia or humanitarian sector (UN-Habitat or Red Cross), and many take higher positions than before the advanced master's degree within the public service.

Analysis summary - Advanced Master of Human Settlements

Strengths

- Programme which is unique in Belgium and that has existed for a long time;
- Programme completely taught in English;
- Strong links with research;
- A final, interactive, presentation of the work of students to both students and stake-holders lasting 2 days;
- Social concerns;
- Dedicated first to developing countries then to major crises;
- Tuition fees are low compared to those in other countries;
- Strong appeal of KU Leuven;
- Easy life in Leuven for students speaking only English;
- Close to Brussels.

Weaknesses

- Lack of communication and information on the programme pre-requisites;
- Lack of help from the university for student housing in Leuven.

Opportunity

- Needs of society related to social transition, ecology and health are growing.

Risks

- Lack of mixing with students in other programmes (advanced master's or master's programmes) except with the Advanced Master of Urbanism, Landscape and Planning;
- Better formalise feedback from students.

Advanced Master of Urbanism, Landscape and Planning - post-master's

As for the Advanced Master of Human Settlement, the advanced programme in Urbanism, Landscape and Planning is organised by the International Centre of Urbanism, Settlements and Environments, which is well known around the world in the field of urbanism, human settlements and landscape management.
The programme is dedicated to qualitative actions in cities and urban territories through projects based on an innovative approach to urbanism, planning and landscape. The future graduates have to respond to major challenges of social inclusion and environmental protection. It is a four-semester (120 ECTS credits) programme that can be taken after a master's programme or a 4-5 year bachelor's programme, depending on the origin of the students. It can also be taken as a continuation of a two-semester (60 ECTS credits) programme after the Advanced Master in Human Settlements.
Three specialisations are possible: urbanism, planning or landscape. The master's thesis can be based either on a design or a planning project.

On average, over the past 5 years (2016-2021), the programme has had 28 students per year, with more than 85% international students. 27 nationalities are represented: 11 in Asia, 6 in North, Central and South America, 5 in Europe, 4 in Africa, 1 in Oceania. The gender balance is 66% female and 34% male. Students can have diverse backgrounds in architecture, planning and/or urban design. The selection is based on their skills in advanced design and on their background in planning and/or urbanism.
The high appeal and the high ratio of international students is due to the well-known expertise of the staff and the fact that the programme is exclusively taught in English.

There are 7 professors for compulsory courses (3 for core courses and 4 for design studios). The staff also includes 1 teaching assistant (Postdoc) and receives help from PhD students for design studios.

The programme benefits from Flemish Interuniversity Council grants, which are scholarships for master's programmes obtained with the ICP Connect programme and for 29 eligible countries, and from partnerships in Latin America, Sub Saharan Africa and Asia.

The flexibility of the programme and the teaching methods based on workshops offer the possibility to respond quickly to major crises and transitions. Recognised across the world but also in Flanders in urban planning, the programme has a unique position within the educational landscape.
The programme began being reformed in 2018, taking effect in 2019-2020. The name changed from Master of Urbanism and Strategic Planning to Master of Urbanism, Landscape and Planning and places more emphasis on the expertise in Landscape Architecture.

New partnerships are developed with research exchanges. Regional hubs are being developed in Latin America, Sub-Saharan Africa and Asia.

The recent reform has resulted in a better distinction between the programme in Human Settlements and the programme in Urbanism, Landscape and Planning.
As a response to the 2016 CTI recommendations, a new website has been created, along with various social media accounts.
Bi-weekly meetings provide follow-up on the way the programme is being run and focus on studio work and some courses.
The annual World Urbanism Seminar keeps on growing and remains one of the highlights of the programme.

Curriculum: programme outcomes and learning outcomes
The programme provides students with the capacity to develop a critical understanding of settlements, cities and urban regions and to contribute with an innovative approach to urbanism, planning and landscape, inspired by "transcultural expressions of worldwide urbanism", respecting the environment and social inclusion.
Even if post-master's are not part of the Bologna process, the courses are described in semesters and have a corresponding amount of credits. Compulsory courses represent 27 ECTS credits (over 2 years), optional courses represent 75 ECTS credits (according to student choice, over 2 years), design studios count as 30 ECTS credits (50% of the third year) and the master's thesis counts as 30 ECTS credits (important part of the second year).

Programme implementation
The programme offers different job training experiences. Moreover, the great diversity of the background of incoming students and their previous experiences broaden the horizon of the entire group.

Research activities
The programme is strongly linked to research. The students are in permanent contact with faculty members, post doctoral staff and PhD students. They participate actively in the yearly World Urbanisms Seminar. The presentation of project results to other students, faculty members and stakeholders encourages research activities.
Several students continue on to a PhD programme.

Training for an international multicultural context
Due to its broad openness to international students and exclusive teaching in English, the programme naturally offers a multicultural context.
Sufficient knowledge of English is required for admission.

Sustainable development, social responsibility and ethics
Sustainability is part of the aim of the programme. The approach to urbanism, planning and landscape is designed to respect the environment and social inclusion.

Educational engineering
Teaching methods in architecture and urbanism programmes are project-based in design studios. During the recent health crisis, different tools were developed so that studios can be conducted remotely or in hybrid situations. In the future, these developments should broaden the spectrum of experts who could be involved in the projects. The programme presents a good mix of practice, projects, theoretical teaching, conferences, and discovery trips.

Student life
Student life seems to be easy in Leuven, even for non-Dutch speaking people, but housing problems represent a real threat. In comparison to other full English post-graduate programmes in other countries, the fees (€3,300) are quite low. However, scholarships and partial tuition waivers given to students from the lowest income of the OECD countries contribute efficiently to the international openness of the programme. A cut of the Flemish Interuniversity Council grants would present a real risk in the future.

Student monitoring / failure management
Due to the small size of their group, the students find that they are well followed. However, the Committee underlines that the feedback to students is not sufficiently formalised. The students really work together but not enough with those in the Master of Engineering: Architecture. This cooperation should be developed for the benefit of all.

Assessment of results
On average, more than 90 % of the students graduate (100 % in 2015 and 2017). However, a large group of students are still enrolled after two years (probably more than 50%).
After graduation, most of the students are employed in the public, private or humanitarian sector. They are able to fulfil high responsibilities quickly.
Part of the students applies for a PhD after the master's programme or later, to pursue an academic career.

Analysis summary - Advanced Master of Urbanism, Landscape and Planning

Strengths

- Programme entirely taught in English;
- Strong link with research;
- Uniqueness of the programme, especially for landscape;
- High appeal and low tuition fees in comparison with other countries;
- High level of recruitment;
- High rate of international students;
- Real enthusiasm of students;
- Ability to produce concrete design projects as a final thesis (instead of written papers);
- Presentation of project results to students, faculty members and stakeholders;
- Good interaction with the Master of Engineering: Architecture;
- Global approach to sustainability;
- Social concerns (e.g. Valley of the Vesdre);
- Grants from the Flemish Interuniversity Council;
- Easy life in Leuven for English-speaking students.

Weaknesses

- Tenuous link with the Advanced Master of Conservation of Monuments and Sites;
- Lack of communication about the prerequisites;
- No possibility of an international accreditation (in engineering).

Opportunities

- Current context of important transitions (ecological, social, health, etc.);
- Low competition (low fees for a full English taught programme).

Risks

- Housing difficulties in Leuven for students;
- Potential risk of funding cut from the Flemish Interuniversity Council;
- Problem of visibility. Two different post-graduate master's programmes with possibility of obtaining one or two degrees in four semesters, but few differences between the Human Settlement programme and the first year of the Urbanism, Landscape and Planning programme.

Advanced Master of Conservation of Monuments and Sites - post-master's

The Master of Conservation of Monuments and Sites (MCMS) programme includes 90 credits (3 semesters) and started at the Faculty of Engineering Science of KU Leuven in the 2014-2015 academic year.
The aim of the programme is to train professionals in the conservation of the built heritage and heritage sites, with an interdisciplinary and international vision. It consists of a revised programme of the famous Raymond Lemaire International Centre for Conservation (RLICC) as a response to the self-evaluation process and to the advice given by the last commission inspection in 2011 and CTI (2016).
The main change since the last evaluation consists in changing the "Integration Project Work" (IPW) course to a two-semester course, due to the lack of time for the project work highlighted in the last evaluation.
The appeal of the programme was developed with a clear strategy for international issues conservation, involving international experts and integrating more options in the first

semester, to broaden the choice for students. The excellent reputation is highlighted by the number of international students (82% in 2020) and interaction with research that results in publications, PhD and postgraduate studies after graduation and the work of the master's thesis.
On average, the programme involves a limited number of students (maximum of 30 students, average of 20), due to high fees.
The programme involves a substantial workload for students, and some organisation difficulties due to the increasing number of guest speakers and the diverse profiles of incoming students, for example for the project tools to be used.

The high level of the educational programme aims for the students to deepen different topics in a research career or to develop self-employed activities. The high number of international speakers enables students to acquire skills in cross-disciplinary approaches, interculturality and collaboration with diverse audiences.
Interculturality is in fact implemented by the number of international students and is indicative of the attractiveness of the programme.
In the first two semesters, the theoretical framework provides a consistent scientific and technical base of knowledge and gives students a necessary, sufficient and indispensable base of skills to exercise the professions in question.

Curriculum: programme outcomes and learning outcomes
The curriculum presents a balance between technical and human sciences and gives students a multi-scaled approach to project developments. The students therefore develop abilities to understand the global issue of monument and site conservation and to be flexible, working in complex environments and skilled in communication.
Even though the post-master's is not part of the Bologna process, the courses are described in semesters and have a corresponding amount of credits.
The programme presents 90 ECTS credits, with an unequal distribution ranging from 28 to 32 credits. Optional courses represent 4 to 6 ECTS credits (according to student choice, first semester). Projects and workshops count as 15 ECTS credits (about 30% of the second semester). The master's thesis counts as 18 ECTS credits (an important part of the third semester).
The syllabus is structured in various components which are not easily translated into the current ECTS system description, with a balance between the theoretical framework, practice in projects and optional courses, which makes the programme stand out.

Programme implementation
The programme offers students experience with research training, professional internships and regular contact with professional speakers. Moreover, the large diversity in the fields of skills of incoming students and their further experiences broaden the horizon of the multicultural group.

Research activities
The programme's focus on research is essentially through the master's thesis in the third semester, but few students finish this work in the semester due the workload. Research activities are also encouraged with seminars, including a seminar week. The high quality of research activities is underlined by the number of students who continue in PhD research.

Training for an international multicultural context
Due to the proportion of international students (over 80% in 2020), the intercultural dimension of the programme is inherent. The international speakers and international dimension of the programme fully contribute to the multicultural context.

Sustainable development, social responsibility and ethics
The field of built heritage and heritage site conservation is particularly useful when it comes to sustainable development, social responsibility and ethics issues, in terms of tourism development, and reuse at different scales for example. These aspects could be developed in terms of restoration.

Educational Engineering
Due to the size of the group, interactions in the multicultural and international group and with international speakers is effective. The teaching methods, especially on projects, are adapted and efficient. Interaction between students of both cohorts allows for co-learning. The "Integrated Project Work" (IPW) or the "thematic week" allows students to practice the theoretical framework.
The programme consists of theoretical and practical courses, which presents a good balance between face-to-face teaching and work in multidisciplinary and multicultural teams, in the context of a high number of international students and speakers, with large fields of skills related to heritage or architecture etc. This balance evolves in the last semester with more individual work (master's thesis) and autonomy.

Student life
Although student life on the Leuven campus is appreciated by the students, the high tuition fees to complete the programme and housing problems should be highlighted.

Student monitoring / failure management
The size of the group of students allows direct feedback and interaction with the staff, but this feedback is not formalised.

Assessment of results
On average, only 75% of the incoming students graduated in the last five years (between 2016 and 2020) due to difficulties to complete the master's thesis in the third semester. This work is combined in the same period with other activities such as internships, so students are still working on graduating 4 semesters after the three "academic" semesters.

Analysis summary – Advanced Master of Conservation of Monuments and Sites

Strengths
- Unique programme in Belgium, and maybe one of the best known programmes in Europe;
- Interdisciplinary, international and multicultural aspect of the programme;
- Proportion of international students;
- Student life is easy in Leuven for international students;
- Appeal of the programme for international students;
- Uniqueness of the programme taught in English: a full English programme encourages internationalisation;
- Number of speakers involved in the programme (invited teachers, for conferences: 15 people from KUL, over 30 outside lecturers) specifically in conservation;
- Annual newsletter (RLICC newsletter) published by the faculty = annual report of activities.

Weaknesses

- Lack of mixing with students in other master's programmes (language problem? Programme subject?);
- Discrepancy between students' and teachers' opinions on interaction between international students and Belgian students;
- Sustainability aspects not very visible in the programme;
- Organisation of the schedule: programme made week by week due to a lot of actors (external actors);
- Ties with alumni to develop employment perspectives;
- High tuition fees;
- Housing difficulties close to the campus for international students.

Opportunities

- Mixing with other students;
- More aspects on renovation, the programme focuses mainly on conservation and restoration;
- Introduce more dedicated courses on sustainability;
- Projects on religious monument renovation which is a current issue;
- Workload for soft skills.

Risks

- Impossible to complete the programme (master's thesis) in three semesters, but it could be done in 2 years, in accordance with European standard master's programmes;
- Even if the University is addressing the student housing issue, the perception of the students is that there is a lack of housing facilities and difficulties to find accommodation;
- Formalisation of the interaction with students via surveys, in addition to informal interaction.

Master of Engineering: Civil Engineering

The Master of Civil Engineering programme comprises 120 ECTS credits organised in three clusters: Common core cluster (33 ECTS credits), option-specific cluster (48 ECTS credits) and master's thesis project and elective courses (39 ECTS credits).
The new programme (started in 2021) intends to be more attractive to international students and more consistent with the optional paths driven by majors and minors of the Bachelor of Engineering. These two elements may help in increasing the number of students in the Master of Civil Engineering programme.
The new programme results from the regular dialogue between the faculty and the Industrial Advisory Board, which is made up of alumni and other professionals from the civil engineering field.

Curriculum: programme outcomes and learning outcomes

The course descriptions are available online and clearly present their content, prerequisites, targeted skills and the type of evaluations. The information is presented in Dutch and in English according to the language options of each cluster. The description of some elective courses is available only in Dutch, especially when coordinated by other faculties. The targeted skills are consistent and balanced.
All teaching activities, project work (including the master's thesis) and internships are associated with a defined amount of ECTS credits.

The duration of each course is clearly indicated in the course description. However the estimation of personal work is not specified. Considering the interest and the involvement of the students in project courses, the specified amount of credits (i.e. 4 ECTS credits, which corresponds to 100 to 120 hours) seems to underestimate the workload.

Programme implementation
The programme implementation is managed by the Programme Committee, which is made up of teaching staff (lecturers and teaching assistants) and students. The agendas and minutes of the meetings are accessible to the entire faculty.
Communication with students is formally based on elected student representatives, who take part in the Programme Committee. Informally, a lot of information is passed on by the very active student union, called VTK.
Formal evaluation of the courses and the teaching practices by students is done on a regular basis via online optional surveys. The participation rate of these surveys is relatively low. Students seem however to be used to more informal and direct dialogue with the teaching staff to solve practical problems about teaching quality.
When problems are detected, a discussion at the Programme Committee level gives rise to a report which is automatically added to the personnel file of the lecturer and is taken into account in a potential application for a promotion.

On-the-job training
There is no specific period during the academic year devoted solely to internships, which in any case are not mandatory. The course schedule is organised to take up the whole academic year, which allows only summer internships or summer jobs. A summer internship gives rise to a technical report and a presentation, and accounts for 3 ECTS credits (Business experience: construction engineering) or 6 ECTS credits (Industrial internship: construction engineering).

Research activities, innovation and entrepreneurship training
The master's thesis accounts for 24 ECTS credits, which represents 20% of the total 120 ECTS credits of the programme. The subjects vary from quite fundamental to applied collaboration with industrial partners. The students have a thesis supervisor, usually a professor or teaching assistant from their programme. In the event of an industrial collaboration, the student can also be coached by an employee of the company.
Workshops about information literacy, intellectual integrity and plagiarism, and academic writing are offered to students, aiming to support the thesis writing process.
At least five optional courses are offered concerning entrepreneurial aspects like economy, management and communication.

Training for an international multicultural context
Three optional courses are offered concerning basic language skills (Dutch, English and French). Other options for learning language are available at the KU Leuven Language Institute.
A considerable effort is being made to attract foreign students in the next 2 years with complete programme options in English. Outgoing mobility is possible, but only for destinations where the study programme is quite similar to the local one.

Sustainable development, social responsibility and ethics
The programme presents at least seven optional courses concerning sustainable development, social responsibility and ethics. The VTK student union proposes discussions about sustainability actions like donating surpluses to the food bank, reducing paper use and making conscious use of transportation means.

Educational engineering
Students and teachers have access to modern auditoriums and classrooms, and laboratories with recent equipment. The students of the programme are assisted in exercise classes, master's theses, and Problem Solving & Design sessions by teaching assistants. Most of the time, these teaching assistants are PhD students working on subjects related to their teaching responsibilities. The faculty has developed a training programme (SWEET²) which is mandatory for all PhD students to ensure the quality of this teaching format.

Scientific skills are developed across all mandatory courses and some optional technical courses. Other skills can be improved in optional general courses. Project work, like Problem-Solving and Design are well-structured opportunities to present concrete situations to students who are then motivated to provide creative solutions in group work.

The programme includes lectures, tutorials, practical work and problem-based learning activities. The COVID pandemic accelerated the development of new teaching methods, especially related to remote classes. Almost all class sessions are available in video, which presents many advantages for the revision of the courses. However, the present number of students who physically attend classes is reduced, which can create problems for the socialisation of the students. Some computer labs intend to implement virtual desktops to simplify the remote use of technical software.

Student life
The students have access to a large field of possibilities for sports activities (pools, gymnasia, stadium, etc.) on Arenberg campi. The faculty supports the VTK student union which offers social activities, low price book sales for students, etc.

Student monitoring / failure management
An important parameter to quantify problems related to the success of students is the extra time in semesters to complete the programme. Special attention is given to international students in order to improve admission procedures and the expected profile of foreign candidates.

Assessment of results
The students seem to receive the necessary information to get involved with the programme. The participation in course evaluation surveys is however relatively low.

Analysis summary – Master of Engineering: Civil Engineering

Strengths:
- New structure of the programme with 3 options in Dutch and 2 options in English;
- Good relationship between teachers and students;
- Good employability of the engineers after graduation;
- High quality and cross-disciplinary Problem Solving and Design projects.

Weaknesses:
- Low response rate of students to programme evaluations;
- Feedback of evaluation to students;
- Presentations of exchange possibilities to students are late in the programme and do not facilitate organising study abroad periods;
- Low number of ECTS credits allocated to Problem Solving and Design projects considering the associated workload;
- Gender balance.

Risks:

- Decreasing flow of students.

Opportunities:

- Development of a virtual teaching framework;
- Structure links with alumni associations;
- Improvement of the visibility of more recent approaches in study programmes (e.g. wood structures, BIM, etc.).

Master of Engineering: Nanoscience, Nanotechnology and Nanoengineering

The programme addresses the need for highly skilled engineers in the field of nano-scale devices for development of technology, devices and use in applications. The master's programme is organised into 2 years and offers 5 options (Nanomaterials & Nano chemistry; Nanodevices & circuits; Nanophysics engineering; Nanobiotechnology; Quantum engineering, Materials and technology). Since the previous CTI evaluation in 2016, the 4 existing options have been slightly redefined for a better coherence and a 5th option on Quantum engineering has been added to address the rapidly progressing technological maturity of this field. The programme launched in 2012 is multidisciplinary by design through the cooperation of 3 faculties. The study programme combines topics from physics, chemistry, biology and electrical engineering. It comprises 33 ECTS credits in core courses, 21 ECTS credits in option-specific courses, 30 ECTS credits for M1 and M2 projects & master's thesis and the remaining 36 ECTS credits split on an individual basis between fundamental courses, general interest courses and broadening elective courses. Admission is open to a wide range of bachelor's profiles. An individually adapted programme of fundamental courses in the first semester makes it possible to compensate for the diversity of prior education. Two professors will jointly direct the programme starting in 2022.

The programme addresses a specifically identified developing need, in nano and quantum technologies and their applications. The individually adapted programme in the first semester provides a common basis of knowledge for all students.

Curriculum: programme outcomes and learning outcomes

The curriculum is well designed and combines a multidisciplinary approach with a well-identified focus on a particular field through the different options. The curriculum is fully consistent with the Bologna process.

The programme is clearly organised, the workload is coherent with the ECTS credits, and all aspects of the teaching units and syllabi are fully described in the online course catalogue. The academic rules of KUL apply to this programme.

On-the-job training

Internships during the summer break are possible but not mandatory. The available period for internships is very short (2 months). The number of credits is 3 or 6 ECTS credits depending on the duration of the internship. The master's project can be done in industry and is evaluated in consistency with masters' projects at the university level. However, both possibilities of on-the-job training are only marginally used by students enrolled in the programme.

Research activities, innovation and entrepreneurship training

The programme is almost entirely delivered by the research faculty. Student exercises and projects are closely integrated into research work and provide excellent preparation for industrial and academic research.
Innovation and entrepreneurship training is offered on an elective basis (3 ECTS credits).

Training for an international multicultural context
English is the working language of the programme. Inbound and outbound student mobility is offered, and the master's has a significant proportion of enrolled foreign students.

Sustainable development, social responsibility and ethics
Sustainable development issues are embedded in various units. A general introduction to sustainable development, social responsibility and ethics would be a welcome addition to the programme.

Educational engineering
Active and online teaching approaches are used for some courses. The faculty promotes and actively supports innovative teaching through dedicated staff and infrastructure.
The programme uses little project-based learning in the first year. Close to half of the second year is dedicated to the master's thesis (24 ECTS credits). More practical learning in the first year would be helpful for a large part of the students, especially for those who did not already receive significant practical training during their bachelor's degree. The portion of the programme delivered by professionals from the business world could be increased to create more ties with industry.
Exercises and first year projects are organised in groups and give a good balance between contact hours and group work.

Student monitoring / failure management
Student results are well monitored. Faculty is available for support to students with difficulties.

Assessment of results
Methods for assessing skills and learning outcomes are clearly defined. Even if practise exams are organised near the end of the first semester for the students from abroad, first semester students sometimes have difficulties evaluating and adjusting expectations related to student performance. Assessment of results and awarding of degrees follow the general principles and rules of KUL.
Promotion of the programme to businesses and participation of professionals in the programme could be increased.
The general services of the Faculty of Engineering Science are available to students, as well as support for entrepreneurship.
Employment surveys exist, but not for every year. The response rate is low and needs to be improved to make the survey meaningful.

Analysis summary - Master of Nanoscience, Nanotechnology and Nanoengineering

Strengths:

- Multidisciplinary and cross-faculty programme;
- Course content is strongly linked to on-going research;
- High agility in adapting the programme to emerging topics.

Weaknesses:

- Few opportunities of experimental work for first year students;
- Low diversity of industrial stakeholders in the programme apart from IMEC and lack of promotion of the programme in industry.

Risks:

- Loss of motivation of faculty members in case of limited recognition of teaching efforts.

Opportunities:

- Further introduction of alternative teaching methods (flipped courses, large PjBL, etc.);
- Improved integration of teaching assistants in the sharing of student feedback;
- Make sustainable development aspects more visible;
- Take advantage of the new European relocation strategy for nano-electronic industry to develop more professional opportunities at the master's level.

Erasmus Mundus Master of Science in Nanoscience and Nanotechnology

The "EMM-Nano+" is an Erasmus Mundus programme fully taught in English. Created in 2012, it was renewed in 2021 thanks to the Erasmus+ instrument and is valid for 6 more academic years (60 EU-funded scholarships overall, last entrance in 2025, last graduating 2027). Joint teaching activities with the local master's "N3" are in place with core courses and disciplinary electives in year 1. With 46 students in 2021 (79 in 2019), it offers future graduate engineers 9 possible specialisations in year 2 within a partner university and delivers a joint degree from KUL and either TU Dresden, University Grenoble-Alpes, University of Barcelona (joint in 2017), or Chalmers. Programme adjustments are supported by the Industrial Advisory Board which has a strong international dimension, as does the EMM-Nano+ board, including coordinators and student representation. Two new programme directors have been in place since 2021-22 for the local EMM-Nano programme.

Interoperability with other European university partners could be scrutinised, as well as the potential ending of the EU scholarship support for newcomers by 2025 to be anticipated, e.g. with new scholarship models with companies to be discussed with the Industrial Advisory Board. Visibility of the degree by major industrial & international stakeholders of the sector is to be handled and reinforced via increased direct and diverse industrial stakeholder presence in the teaching and learning activities, internships or thesis co-offers. The programme has the opportunity to enrich dynamic and course quality enhancements with smooth interactions between the new directors, teachers, teaching assistants and students, thanks to the existing positive atmosphere. The programme is clearly documented in its external website.

Curriculum: programme outcomes and learning outcomes

The programme has a strong international dimension with unique European graduate profiles. Targeted skills are aligned via a curriculum matrix with 21 graduate outcomes classified into 7 categories, with a very clear curriculum structure and a large choice of electives and specialisations in the 4 partner European universities. Alignment of programme outcomes with course content should ensure improved consistency and comprehensiveness as with Eur-Ace® graduate outcomes.

Programme implementation

Once they have graduated, students are able to work directly in fundamental or applied sciences. The EMM-Nano+ is a clear multi-choice programme that maintains a balance between core knowledge & fundamentals. Nine specialisations are available in year 2 (3 at TU Dresden, 3 at U. Grenoble-Alpes, 2 at Chalmers, 2 at U. Barcelona), with higher popularity for the nanotech specialisation at the expense of other partner universities. As an interfaculty programme at the EU level, it has the agility to adapt to new topical needs and supports a high scientific level thanks to permanent research-oriented teaching staff and top-tier partner universities. Few introductory MOOCs could be integrated in the programme in an autonomous learning model.

There is a good balance between full-time, part-time teachers and teaching assistants, which is satisfactory regarding expertise, variety and needs. The structure of the programme is very clear and flexible to students in order to personalise their learning itinerary. The programme is underpinned by a blend of fundamental courses of up to 12 ECTS credits (among 8 courses of 3 ECTS credits), general interest courses (6 to 9 ECTS credits), 36 ECTS credits for core courses, a pool of more than 10 electives in English, as well as 6 to 18 ECTS credits for profiling electives (15 proposals of 3 to 6 ECTS credits). Objectives of the programme are clearly stated, and the programme sufficiently aims for active learning and cooperative learning. Learning styles somehow differ between partner institutions in year 2. As an engineering degree, the team-based capacities such as project quality, costs & deadline management skills are still questionable with respect to the strong research orientation. As well, more explicit formalisation of soft and cross-disciplinary skills should be envisioned. Education and examination regulations are clear; the assessment criteria are communicated beforehand. Assessment rubrics should be made consistent across partner universities and harmonised based on best practices. For master's theses, students are assessed on process, product and communication skills. It would be appropriate to standardise assessment grids with the partners. Student workload is heavy in the 1st semester, even more so for students who need to follow courses in fundamentals and/or international students not accustomed to the learning model. More regular and complete feedback (KUL, CQAB and 4 partner institutions) for systemic quality enhancement may be ensured in a yearly analysis. Students can have a diploma supplement that follows the European model.

Training for an international multicultural context

As an Erasmus Mundus programme, the second year of the master's is spent in a different EU country. Based on the criteria of the 2018-19 student feedback, it is well recognised that the programme provides enough possibilities to gain international experience. There is a good cooperation model between the partner institutions supported by the EMM-Nano+ Spring Workshop, in which students spend 1 week in spring at one of the partner locations, with practical cleanroom training so as to enrich international and intercultural experiences. For the last 6 academic years, 8 students participated in the one week Athens course (3 ECTS).

Research activities, innovation and entrepreneurship training

A master's thesis of 30 ECTS credits with a strong research dimension with top-level laboratories takes place at one of the partner institutions. The jury always includes a KUL member as "co-promoter". Strong research lab connections (e.g. IMEC, IFW Dresden, CEA-Leti) are in place to generate new fundamental knowledge and innovations, which provide the expertise and innovation skills needed. Further experience in companies may be overseen via curricular flexibility or extensibility as internships are seen as a profiling elective (6 ECTS credits).

Clearer programme outcomes on entrepreneurship may appear, as industrial project manager or business profiles.

Student life

According to the Course Quality Advisory Board of the Erasmus Mundus Student and Alumni Association survey conducted in 2017, formats such as the "Buddy or tutor system" are to be reviewed for enhanced quality of student services to smooth integration of students at partner Universities in year 2, with respect to information systems, housing facilities, intra and extra administrative services, or extra fees.

Sustainable development, social responsibility and ethics
Ethics are covered in some mandatory courses. All students are invited to an information session dealing with scientific integrity and plagiarism. Student awareness of their social, ethical and ecological responsibility is formally linked to only a few courses. Alignments with the challenges and perspectives of sustainable and social responsibility objectives in companies should be envisioned. A MOOC to earn study credit e.g. on Sustainable Development Goals could be formalised in the programme.

Student selection and admission
The majority of incoming students are from outside the EU (96% in 2017, 83% in 2021) with the support of the EU scholarship scheme for top students (approx. €1,400 per month). The number of incoming students has decreased during the COVID sanitary crisis. On average, 35% of EMM-Nano+ newcomers are female students and from various international sources. The gender balance among teaching staff stands at up to 25% females at full-time faculty level.
KU Leuven offers services which enables interested students to learn more about the programme or admission requirements before applying. In spring 2022, four EMM-Nano+ students from India, Vietnam and Russia were acting as ambassadors in the online "chat with our students".

Analysis summary- Erasmus Mundus Master of Science in Nanoscience and Nanotechnology

Strengths:

- Interfaculty programme at EU level, with real agility on adaptation to new nanoscience & nanotech needs;
- High scientific level with permanent research teaching staff and top-tier partner universities;
- Strong research focus with top-level laboratories for concrete master's thesis;
- Clear international dimension with unique worldwide graduate profiles;
- EU scholarships for top students and excellent rate of PhD enrolment after graduation;
- Good student gender balance and international diversity of incoming student sources;
- Course on entrepreneurship;
- The faculty leads two research projects (among the seven included in the overall EIT-KIC programme);
- High number of international students.

Weaknesses:

- Professional pathways of students in industry or private sector mainly after PhD tracks;
- Lack of degree visibility outside the industrial partner stakeholders in the sector;
- Irregular and low response rates of students and alumni for longitudinal analysis;
- High and non-homogeneous study workload in year 1 courses, e.g. for international students not accustomed to the learning model;
- Lower elective choices in year 1 for students to engage in several harmonisation fundamental courses ;
- Low explicit formalisation of soft and cross-disciplinary skills in course syllabi;
- The course evaluation programme is used very little by students;
- Lack of soft skills (understanding of the business world and ability to be quickly operational in a company);
- Action plans following previous CTI recommendations have not been fully completed;
- The course evaluation programme is used very little by students;
- Lack of soft skills (understanding of the business world and ability to be quickly operational in a company);
- Action plans following previous CTI recommendations have not been fully completed.

Risks:

- Potential ending of the EU scholarship support for newcomers by 2026;
- Extra fees for enrolment in year 2 at some partner institutions;
- Too high popularity of a specialisation at one partner institution at the expense of other partner universities;
- Entrepreneur and industrial project manager or business profiles scrambled with respect to high research profiles linked to PhD tracks.

Opportunities:

- New scholarship funding models to investigate with the Industrial Advisory Board;
- Clearer and realigned curriculum mapping with the programme outcomes to reinforce student appreciation of the EMN-Nano+ outcomes and targeted skills;
- Reinforce visibility of the degree in the international industry sector thanks to internship or thesis offers;
- Opportunities for long internships in companies with curricular flexibility or extensibility;
- Regular and more complete feedback analysis (KUL, CQAB and 4 partner institutions) for quality enhancements fully targeted to the multisite specificities;
- propose a new business model to increase funding and guarantee the sustainability of the programme.

Master of Engineering: Biomedical Engineering

The programme addresses the increasing role of technologies in healthcare and the need for experts able to integrate knowledge from both the medical and technological fields.
The programme relies on technological backgrounds from mechanical, electrical, computer science and materials engineering.
The programme is aimed at training professionals who are able to design and produce medical devices and new healthcare methods and deploy them within the clinical practice. Therefore, the programme also includes regulatory, innovation and ethical aspects of biomedical engineering.
The programme has been adapted to the fact that new major (48 credits) and minor (33 credits) options in biomedical engineering were implemented in the Bachelor of Engineering

programme from 2019-2020 in accordance with a previous CTI recommendation. This allows the introduction of human anatomy, cell biology and physiology directly in the bachelor's programme which leads to master's students being more acquainted with the basic notions of medicine.
The master's programme is built around a common core of 43 credits, 35 credits for elective courses, 12 credits for general interest courses and 30 credits for research training and the master's thesis.
The programme benefits from connections to UC Louvain, Athens courses and potential industrial internships.
The programme is nurtured by the strong research activity of the professors. It benefits from an outstanding surrounding ecosystem including one of the best hospitals in Europe (UZ Leuven, campus Gasthuisberg) and very active high-tech healthcare companies around the Leuven University.
The programme addresses a specifically identified need in the development of technologies for health and their practical introduction into new healthcare methods. An Industrial Advisory Board has been implemented and the programme is well matched for the needs of the industry but is also a good path towards PhD studies (nearly 25% of the students).

Curriculum: programme outcomes and learning outcomes
The curriculum corresponds to the targeted training, i.e. to develop multidisciplinary experts who are able to translate advanced technologies into clinical workflows.
The curriculum is fully consistent with the Bologna process.
The programme is clearly organised, the workload is consistent with the ECTS credits, and all aspects of the teaching units are fully described in the online course catalogue. The programme has been updated to take into account the new major/minor programme at the bachelor's level.

Programme implementation
The academic rules of KUL apply to this programme.

On-the-job training
The programme includes activities in clinical environments and research training activities dedicated to MedTech.

Research activities, innovation and entrepreneurship training
The programme is almost entirely delivered by the research faculty. Student exercises and projects are tightly integrated into research work and provide excellent preparation for industrial, clinical or academic work.
Innovation and entrepreneurship training is offered on an elective basis.

Training for an international multicultural context
English is the working language of the programme. Inbound and outbound student mobility is offered, and the master's has a significant proportion of enrolled foreign students.

Sustainable development, social responsibility and ethics
Ethical issues in biomedical engineering are optional but should be mandatory.

Educational engineering
Active and online teaching approaches are used for some courses. The faculty promotes and actively supports innovative teaching through dedicated staff and infrastructures, including work in the clinical environment.
The programme is well balanced. Challenge-based learning inside the lectures could be more developed.

Exercises and first-year projects are organised in groups and give a good balance between contact hours and group work.

Student life
The programme attracts both international students and “lateral entry” students which gives the classes a very interesting multicultural aspect. The gender aspect of the group is well balanced (nearly 50-50).

Student monitoring / failure management
Student results are well monitored. Faculty is available for support to students with difficulties.

Assessment of results
Methods for assessing skills and learning outcomes are clearly defined. However, first semester students without a KU Leuven bachelor’s background sometimes have difficulties to measure accurately and to adjust to the expectations related to student performance. Assessment of results and awarding of degrees follow the general principles and rules of KU Leuven. Overall, this programme shows excellent development, connection to the bachelor’s programme. New subjects recently introduced means the programme only requires fine tuning.

Summary analysis - Master of Engineering: Biomedical Engineering

Strengths
- Programme linked to one of the top university hospitals in Europe;
- Good connection to research activities;
- Broad panel of employment fields (not only in biomed but also in computer science and consultancy for example);
- Alumni survey has been implemented;
- Involvement of end users (MDs) in some teaching activities;
- Good gender balance in the recruitment;
- Lateral entry with a specific gate;
- Very good mix of students including parallel admitted and and foreign students;
- Frequency of meetings of the Industrial Advisory Board;
- Good mix of master's thesis topics (research + industrial);
- Good proportion of master's students who go on for a PhD;
- Excellent development, connection to the bachelor’s programme and new subjects recently introduced means the programme only requires fine tuning;
- New lectures on regulatory affairs and medical equipment;
- Elective courses allow students to build a very personalised programme. The organisation in clusters of courses in elective packages is very much appreciated;
- Guest lecturers from high-tech companies (from a nice local ecosystem);
- Excellent accessibility to teachers;
- Excellent logistics and caring for foreign students;
- Master's thesis topics with large problems to solve.

Weaknesses
- Ethics classes (important for biomed) should be compulsory;
- Weak response rate to alumni survey;
- Informal contacts between professors should be stimulated;
- Advanced use of Python (notebooks for fast prototyping for example) should be promoted in more courses (requested for employability);
- Sometimes difficult connections between entities in and out of the UZ Leuven hospital;
- Balance between the MedTech and Pharma-targeted industry;
- Project-based learning not implemented enough;
- Intermediate feedbacks/evaluations would be appreciated.

Opportunities
- Connection to UCLouvain in medical physics;
- Development of MOOCs (biomed is a broad field);
- Initiation to lifelong learning;
- Development of virtual teaching framework;
- ATHENS international experience;
- Developed use of the ERASMUS+ programme;
- Project-based learning;
- Bi-modal classes (online-offline);
- Create a community of alumni through in-person events and social networking for example through LinkedIn.

Risks
- Topics which are too broad (even if clusters of courses in elective packages have been designed to mitigate this risk);
- Imbalance between engineering skills and medical skills, since medical courses are taught in the bachelor's programme;
- MedTech-driven programme;
- Professors working at the university hospital are less accessible to students.

Master of Engineering: Energy
EIT-KIC Master in Energy

The general structure of the programme is consistent with an objective of 300 ECTS credits in ten semesters (180 ECTS credits in six semesters for the bachelor's programme plus 120 ECTS credits in four semesters for the master's degree). The first year of the Master of Energy offers core courses for all students (54 ECTS credits for regular courses and 6 Problem Solving and engineering Design courses) while the second year proposes three options, each worth 24 ECTS credits, 12 ECTS credits for elective courses and 24 ECTS credits for the thesis. While the first year of the EIT-KIC Master of Energy has a quite similar organisation (54 mandatory ECTS credits and 6 ECTS project credits), the second year must be completed abroad in one of three universities located either in Sweden, France or Spain for students taking the "Energy for Smart Cities" track. Students choosing "Smart Energy Systems & Networks" do a first compulsory year at KTH and then may join KU Leuven for a second year with elective courses. It also offers the thesis (24 ECTS credits or 30 ECTS credits for the EIT-KIC master's) plus elective courses and extra activities; it is highly focused on entrepreneurship.

Both master's programmes are closely aligned with the expectations from various industries (of course, energy in a broad sense but also other industries such as transportation, construction, etc.), society (fight against global warming, transition to sustainable energy)

and, last but not least, students highly motivated to tackle these issues. In addition, the EIT-KIC master's addresses an international audience willing to focus on innovation, entrepreneurship and business development in general. The positioning of these master's programmes is clearly a real strength. The scientific and technical skills are common to both masters', mainly based upon electrical and mechanical engineering applied to energy combined with socio-economic issues.
Overall, the courses address the key scientific and technical (and also socio-economic) knowledge required in the field of energy. Both master's programmes offer a comprehensive overview of all relevant subjects and allow for more specialised knowledge through a selection of elective courses. The second year options in the energy master's programme are clearly defined and sufficiently different to meet the specific needs of the industries concerned, while the EIT-KIC master's programme offers an interesting specialisation in the field of innovation, new technologies and entrepreneurship. In the energy master's programme, there is a minimum of compulsory courses (12 credits) addressing these topics to ensure that the students have acquired the knowledge in these fields.
All students must prove their English proficiency during the admission process.
While in the EIT-KIC master's degree the percentage of foreign students is significantly high and there is a mandatory year abroad, the exposure to multiculturalism could be increased in the energy master's degree. The fact that the internship is not mandatory, in general, and with no specific incentive to go abroad, does not help solve the problem.

Curriculum: programme outcomes and learning outcomes
The ECTS credits are distributed in a consistent way between the different courses throughout the curriculum. As already mentioned, the number of ECTS credits to be obtained for the degree is in line with the Bologna process, with 180 acquired with the bachelor's degree and 120 in the two years of the master's.
The faculty has adopted the Academic Skills and Quality Assurance framework to describe programme outcomes according to seven fields of expertise. The curriculum mapping describes, for all core and elective courses, how skills are acquired and validated for each of the seven competency areas. On the other hand, ECTS credits are attributed to each core or elective course. Consequently, the link between teaching units (courses) and skills is provided.
In terms of workload, 25 to 30 hours are allocated for each ECTS credit (whatever the teaching method), i.e. a total of 1 500 to 1 800 hours per year. It gives a fairly high maximum value but remains compatible with the students' abilities.
The syllabus is available in Dutch and / or English depending on the course and the master's programme.
The version of the curriculum mapping provided for the evaluation was done in 2014 and it is said that few changes have been made since then. However, for this subject, one would have expected a more recent update: even if the technical basics have not changed, the uses and analysis of energy needs are evolving rapidly and could be reflected in the programme (notions of systems, LCA, etc.).

Programme implementation
The programme implementation complies with the faculty rules, which in turn comply with the Flemish government requirements.

On-the-job training
Internships are possible but remain very rare. Among the reasons given, they must be done during the summer and students are not paid. On the other hand, former students we met complained about their lack of understanding and preparation for "real" life in industry. Strengthening student contact with industry was one of the recommendations of the last CTI evaluation and more work is needed in this area. They are no apprenticeship programmes.

Research activities, innovation and entrepreneurship training
Research activities are part of the programme and are encouraged by the professors. Students recognise that they are in very good conditions to develop research even if few of them pursue with doctoral studies because of the easy access to good, well-paid jobs.

Innovation and entrepreneurship education are at the heart of the EIT-KIC master's programme. In the energy master's programme, students take courses (12 credits) on these issues.

Training for an international multicultural context
As already mentioned:

- All students must prove their English proficiency during the admission process, according to the faculty regulations;
- While in the EIT-KIC master's degree the percentage of foreign students is significantly high and there is a mandatory year abroad, the exposure to multiculturalism could be increased in the energy master's degree, even if some courses are shared with the EIT-KIC master's students.

In addition, the incoming mobility of foreign students remains quite low. Increasing the incoming mobility would be beneficial for the development of multiculturalism (having more contacts with foreign students) and the global image of the faculty.

Sustainable development, social responsibility and ethics
Sustainability is considered at the faculty level and is an important part of courses in both master's programmes.

Educational engineering
The programmes developed case studies, projects and two Problem Solving and Design courses:

- For the energy master's programme: 'Integrated Problem Solving in Energy' (IPSE) and 'Integrated Project in Energy' (IPE), with an emphasis on design, related aspects of teamwork, and reporting;
- For the EIT-KIC master's in energy: Hands-on integrated Project on Innovative Energy Systems, part 1 and 2, that also tackle innovation and entrepreneurship aspects.

The balance between theory, practice, innovation and projects is compliant with expectations.
The development of MOOCs' has started, boosted by the COVID-19 sanitary crisis, and continues to be implemented. Professors are aware of both the interests and drawbacks of MOOCs and have regular meetings to discuss these issues.

Student life
The programme does offer nothing specific in this area apart from the description in the general assessment of the faculty above.

Student monitoring / failure management
In addition to the general rules of the faculty, students have mentioned that professors are highly available to discuss general and personal issues in this matter. The professors we met also state that they are fully available to support students.
However, the evaluation process (i.e., student feedback on courses) is not very well implemented (low level of responses) and may need to be reviewed and improved to increase its use and efficiency.

Assessment of results
The assessment of results complies with the faculty rules, which in turn comply with the Flemish government requirements.

Analysis summary
Master of engineering: Energy
EIT-KIC Master of Energy

Strengths:
- The energy master's degree is very well positioned in relation to the expectations of society and industries;
- Growing interest of students for energy and, more widely, for all topics related to climate change and sustainability;
- The curriculum provides a broad overview of all topics involved and enables students to acquire more specialised knowledge thanks to a selection of options;
- Students find a job very easily (there is a high demand);
- The teaching staff is very accessible to students;
- Thanks to the high quality of education, students have opportunities to join a research programme (PhD).

Specific to the EIT-KIC master's:
- Course on entrepreneurship;
- The faculty leads two research projects (among the seven included in the overall EIT-KIC programme);
- High number of international students.

Weaknesses:
- The course evaluation programme is used very little by students;
- Lack of soft skills (understanding of the business world and ability to be quickly operational in a company);
- Action plans following previous CTI recommendations have not been fully implemented;

Specific to the energy master's:
- Low number of incoming international students;
- Courses about innovation, entrepreneurship are only options.

Risks:
- The continued decrease in funding jeopardises the sustainability of the EIT-KIC master's degree;
- The attractiveness of the energy master's degree remains low for international students.

Opportunities:
- Propose operational solutions to increase the level of industry experience of students before graduation such as long-term internships or a gap year;
- Take advantage of the current reflections on the content of the programmes to consider the energy system in its entirety and in a life cycle logic (from the extraction of raw materials to the recycling of materials and energy production/transport and distribution facilities);
- In the same manner, think about placing the different uses of energy by industries, public services and end customers at the centre of the process;
- Strengthen and develop new collaborations within EnergyVille.

Specific to the EIT-KIC Master's:
- Propose a new business model to increase funding and guarantee the sustainability of the programme.

Master of Engineering: Mechanical Engineering

Mechanical engineering is a broad multidisciplinary area of study that covers and combines almost all disciplines of technology. The mechanical engineering programme encompasses development, design, manufacturing, testing, maintenance of machines, devices, vehicles, (structural) systems, as well as research on these topics. The master's programme has three variants:
1. a Dutch-language variant for students with a bachelor's degree with a major or minor in mechanical engineering from the Faculty of Engineering Science;
2. a Dutch-language variant for students with a master's degree in Electromechanical Engineering Technology;
3. an English-language variant for international students with a bachelor's degree to whom admission is granted after evaluation of the application file. Also, KUL students with a bachelor's degree with a major or minor in mechanical engineering can join this variant.

On average, 106 students enrol in the master's taught in Dutch, and 21 in the English-variant programme. The number of students from abroad had a peak of 35 in 2018-19 before decreasing to 17 due to the COVID sanitary crisis. Yearly, around 90 students receive the master's degree in the Dutch-variant programme and 11 on average in the English-variant programme.
A key element in the programme is direct training in a real-life industrial or research setting. Furthermore, all basic sciences, engineering and technology are integrated in the programme delivering graduates that find employment in a wide range of sectors in industry, consultancy and academia.

Curriculum: programme outcomes and learning outcomes

The mechanical engineering skills encompass doing research and designing in real industrial situations with a scientific approach and professional skills (e.g. cooperation, communication, social context). The skills are covered by the courses and projects delivered in the programme such that in general, more than one competency is covered within a course or project as depicted in the skills/course matrix.
The soft and academic skills that are taught are integrated in different courses, projects and the thesis.
Internships can be completed as an elective course and via the ERASMUS+ and ATHENS programmes. Students are encouraged to study abroad.
The two-year programme (120 credits in total) globally consists of a core part (29-35 credits depending on the variant) that is mandatory for all students and a part that is determined by five options of which the students can choose (30-41 credits depending on the variant) from: Manufacturing and Management, Mechatronics and Robotics, Thermo-technical sciences, Aerospace technology and Vehicle technology. Furthermore, there is room for general broadening (max. 6 credits) and general interest (12-14 credits only for variants 1 and 3). A thesis (24 credits) marks the completion of the programme.
The core part offers in-depth training on different aspects of the broad field of mechanical engineering. Via the options and electives, students can prepare themselves for a future in academia and different industrial sectors on technical, management and organisational aspects and doing scientific research and development.

Programme implementation

An internship in an industrial environment is an elective within the programme. In practice, it has an undervalued role and appreciation. Two industrial projects entirely defined by a company, are a mandatory part of the bachelor's (9 credits) and the master's programme (6 credits). Although the project is done at the university, there is frequent contact between the

students and the company involved. Furthermore, the programme gives the students the opportunity to do the master's thesis assignment in cooperation with industry.

Research activities, innovation and entrepreneurship training
The research skills that are taught are spread over the programme in different courses and projects and form an important part of the master's thesis project. In the programme, people from industry are involved that teach part-time. Furthermore, most teaching staff members are involved in projects with industry and some members of the teaching staff hold a part-time position in industry. That way, aspects of innovation and entrepreneurship are taught as well. In Reuter's ranking of most innovative universities KU Leuven is ranked as number 1 in Europe**.**

Training for an international multicultural context
The (teaching) staff of the programme is heavily involved in international research projects that reflects positively on the students. In the third year of the bachelor's programme, students are informed about the ERASMUS+ exchange programme. In the master's programme, students can spend one or even two semesters abroad. Students also have the opportunity to take a one-week course at one of the partner universities in Europe (ATHENS programme). Between 15 and 20 students participate in an ERASMUS+ mobility each year and around 20 students join the ATHENS programme.

Sustainable development, social responsibility and ethics
These aspects are indirectly covered by the social context competency. Furthermore, Religions is a compulsory course for all engineering master's programmes.

Educational engineering
The programme provides a balance between different aspects of the broad field of mechanical engineering and in-depth theory, project work, collaboration skills and presentations skills. Due to the COVID sanitary crisis, online teaching has developed strongly.

Student monitoring / failure management
In 2013, the 'English-language variant' of the programme was introduced. Since then (English speaking) international students have enrolled. The experience is that the average results of international students are lower than those of the Flemish students. The Programme Committee is aware of this and is searching for solutions.
After graduation, students can immediately start with a job in industry or in academia.

Assessment of results
Assessment is mostly done via written exams, oral exams or assignments. For courses with less than 60 students, there is a preference for oral exams or assignments. Oral examination allows teachers to check the knowledge not only on the specific subjects but also on the overall understanding of the programme.
For the Dutch-variant programme, 75% of a cohort of new students successfully leaves the ME programme within 2 years with a degree and 88% within 5 years.

Analysis summary – Master of Engineering: Mechanical Engineering

Strengths:

- Combination of a broad and in-depth programme;
- Connection with the front line of research;
- Good informal connection with industry as proven by the numerous project-based partnerships;
- Training in real-life industrial or research setting;
- Very good employability.

Weaknesses:

- Internships have an undervalued role and appreciation;
- The course evaluation process is not representative due to the low response rates. Students perceive a lack of transparency in the processing procedure.

Opportunities:

- Formalise the connection with industry via the Industrial Advisory Board from the academic year 2022-23 on, as recommended by CTI in 2016;
- Further develop and implement active teaching methods for the whole programme.

Risks:

- The high turnover rate of teaching assistants (PhD students) is a risk for the stability of the programme;
- Be aware that a heavy workload could affect the mental well-being of teaching staff and teaching assistants.

Master of Engineering: Electrical Engineering

The programme is a four-semester (120 credits) programme following a six-semester bachelor's education in which students are trained to become engineers with a solid expertise in the broad field of electrical engineering, with an in-depth specialisation in one of the offered sub-fields and with strong academic skills. On top of the core education (21 credits), students need to select a sub-programme out of four options (60 credits). Further elective courses (15 credits) and a master's thesis project (24 credits) complete the programme.

The options give students the opportunity to specialise in one of four areas: (1) electronics and chip design, (2) power systems and automation, (3) information systems and signal processing, and (4) ICT security and networks. The programme has a strong connection to frontline research, and many of the lecturers who teach in the programme are top international researchers, allowing students to get access to a high-quality research environment.

Major changes that have been implemented in the past years include an increase in the number of options that are offered to students from two to four, and encouraging local students to follow the international (English language) programme.

The first point has given rise to a clearer positioning of the different options towards students, as well as better distribution of students across the different research groups within the department.

The second point is an important step towards merging the local and international students into a single student community. This has led to a substantial shift of student numbers from the Dutch programme to the international programme.

The number of students in the programme is around 130, of whom 90% are in the English and 10% in the Dutch programme and the number of female students is around 15%.

Curriculum: programme outcomes and learning outcomes
There are clearly defined learning goals culminating in 30 relatively detailed programme outcomes. The curriculum mapping, showing which programme outcomes are covered in which programme elements, is from 2014 while there have been important structural changes to the programme since. However, the curriculum mapping is in the process of being revised. Programme outcomes and skills are not mentioned in the course descriptions but are available in the programme guide.
Research skills are developed in the Problem Solving and Design courses, as well as in the master's thesis. With new master's programmes in Artificial Intelligence, Mathematical Engineering, Energy and Computer Science, the Electrical Engineering programme runs the risk of eventually losing ground. It is recommended that these new developments be embraced and incorporated in the programme where appropriate, while utilising this in the positioning and advertising of the programme.
There are well-established structures for the design and approval of the programme. However, there could be a stronger involvement of external stakeholders, companies and other market actors in this process in order to make sure that future needs in expertise and skills are well incorporated into the engineering programme.

Research activities
Most courses are delivered by top international researchers in their field. The master's thesis, which accounts for 24 ECTS credits, is an individual project executed in a strong research environment. It allows students to develop their research skills under supervision.

On-the-job training
Internships are offered as an elective course. Internships as well as technical student jobs are well available and executed by many students.

International and multicultural context
The student population is international and multicultural. After an initial period of having segregated groups, actions are being taken now to create one multicultural community, e.g., by creating multicultural teams in group projects. Also teaching assistants are dominantly international, while the number of international professors is around 15%.
The number of students that study a semester abroad is satisfactory. Most often the ATHENS programme/network is used for student exchanges.

Educational engineering
The students and teachers have access to modern facilities with recent equipment. The students of the programme are usually assisted by teaching assistants (TA) during exercise sessions, master's thesis and Problem Solving & Design sessions. The faculty has introduced a mandatory training programme (SWEET²) to ensure the quality of their teaching activities.
Scientific skills are developed across all compulsory courses and optional specific courses. Other skills can be improved in optional general interest courses. In project work, concrete situations are presented to students who are then motivated to propose creative solutions in group work.
While the assessment of knowledge learning goals is relatively clear, the assessment methods for skills-type learning goals could be made more explicit.
The programme comprises lectures, tutorials, practical work and problem-based learning activities. The COVID pandemic accelerated the development of new teaching methods,

especially related to remote classes. Lecturers are very much satisfied with the strong support from the ICT services in these recent developments.

Student monitoring / failure management
The average study period for obtaining the master's degree varies quite significantly between the groups of local and international students. International students on average take a couple of months longer. Rather than referring to the cultural and social transition period that the international students have to go through, actions should be taken to avoid serious delays and improve the mentoring of students to achieve this. Once students are accepted to enter the programme, they should have a fair chance to complete the programme in time.

The students seem to receive the necessary information to get involved with the programme, choose one of the four "options", prepare their graduation, choosing internships, exchanges, the master's thesis subject, etc. For the important aspect of choosing an "option'', which students need do very early on in the programme, it may be beneficial to strengthen the mentoring of students to support them in making their selection.

Analysis summary – Master of Engineering: Electrical Engineering

Strengths
- Strong research environment;
- Strong relationship between teaching and research;
- Solid programme; good move towards 4 options in 2019;
- Easily approachable and supportive teaching staff;
- Good numbers of inflow of master's students.

Weaknesses
- Gender balance;
- Soft skills development has a lack of explicit criteria and visibility in the programme.

Opportunities
- Extending the collaboration with and the role of the Industrial Advisory Board, including input for education;
- Improved mentoring of (international) students;
- Attracting more (female) students.

Risks
- Competition with other master's programmes within KUL might diminish the position of the Master in Electrical Engineering and requires strategic positioning and communication.

The English variant of the programme has been offered since the 2017/2018 academic year. It offers 120 ECTS credits, taught in Dutch and English. The programme is well developed. After a preparatory section (28 ECTS) the programme contains two main compulsory pathways: “Mobility” (14 ECTS), “Supply Chains” (18 ECTS) and a joint pathway (12 ECTS). Remedial courses are offered both in basic subjects and pathway subjects. The elective/remedial section (maximum 37 ECTS) and the master’s thesis (24 ECTS) complete the programme. The programme rewards internships and requires between 9 and 13 ECTS training on non-technical topics (mostly soft skills).
The programme serves overall a very relevant societal demand due to a general shortage of transportation engineers and an increasing need for engineers who can work on both issues simultaneously. The mobility component, as well as the combination of topics, is not addressed by any other university in Belgium, which makes the programme of critical importance to serve a national need in government and industry. Only a handful of examples of equivalent programmes exist in Europe. The programme material was created by internationally renowned scholars and is of high academic quality. As a result, the programme can also be regarded as internationally relevant and competitive.
The quality of the programme is also monitored by the students and results in a high level of satisfaction. An Industrial Advisory Board was created to help evaluate relevance and identify new needs.

Curriculum: programme outcomes and learning outcomes
An Academic Skills and Quality Assurance compliant curriculum mapping of teaching units to programme outcomes is available in detail but requires more regular updating. The curriculum mapping is currently in the process of being updated. Consistency of teaching material is high at the programme level.

On the job training
Internships are offered but not mandatory. Administrative arrangements are well-prepared to manage the interests of students, companies and the university.

Innovation and entrepreneurship training, multicultural context
The innovation and entrepreneurship training as well as the multicultural context training is provided at the faculty level and adopted by the programme.
Four external part-time, highly qualified senior professionals with significant teaching contribution are involved in the programme. The courses they teach are much appreciated by the students.

Analysis summary – Master of Engineering: Mobility and Supply Chain Engineering

Strengths

- The programme has reached a high level of performance and shows continuous improvement after a good follow up on recommendations, which is a sign of maturity and good health;
- The programme is very distinctive among similar programmes. The traffic engineering pathway is unique for Belgium, has an important function for the improvement of the national transport system and creates strong demand. The integration of the 2 pathways puts the programme into a leading position in Europe when it comes to using the synergies of the two systems;
- Students are very well taken care of and feel motivated and engaged.

Weaknesses

- Despite the many efforts and the growing number of students, the programme is still not visible enough to bachelor's students. This limits the inflow of students, reduces the connectedness to the national engineering education trajectory and constrains delivery of sufficient engineers into practice.

Opportunities

- A further integration and streamlining of the 2 pathways of the programme (mobility and supply chain engineering) will strengthen the unique position in teaching in Europe, improve attractiveness for students and support the development of research leadership;
- After the creation of the Industrial Advisory Board, its members could be more strongly involved by increasing the frequency of meetings, to support hands-on experience in education (internships, public relations, vacancies) and to attract more students;
- Given the good relationships with students, involving them in various associations or committee activities could give more visibility to the programme;
- There is further potential to attract more bachelor's students, in particular at the faculty level. The current supply is well below demand and, given experiences abroad, there is strong potential to increase the student numbers. Better use of the info day for bachelor's students, dedicated courses or lectures, and specific events organised on campus to create more visibility deserve serious consideration.

Risks

- As experienced during the past few years, the dependence of the programme on international students makes it more vulnerable to external factors. Improving the inflow from national bachelor's students is important to provide stability.

Advanced Master of Nuclear Engineering

As there were no CTI recommendations in 2016, this was not an issue during the CTI evaluation procedure in 2022.

The Advanced Master of Nuclear Engineering (BNEN) is a joint effort of a consortium of six Belgian universities and the Belgian Nuclear Research Centre (SCK CEN). Public authorities, regulators and industry also provide their support.

It is a demanding programme where students with different high-level backgrounds in engineering have to immerse themselves in highly theoretical subjects like neutron reactor physics, fluid flow and heat transfer modelling, and apply them to reactor design, nuclear safety and plant operation and control. At a more interdisciplinary level, the programme includes important chapters on materials science, with a particular interest for the fuel cycle. Radiation protection is also part of the backbone of the programme. To meet the future nuclear skills needed in the broader nuclear context, the programme also addresses decommissioning and waste disposal and integrates a module on the social aspects of nuclear applications. The full programme is hosted in Mol, Belgium. All subjects are taught by academics appointed by the partner universities. The practical exercises and laboratory sessions are supervised by researchers of SCK CEN. The final thesis offers an opportunity for internships in industry or in a research laboratory. The programme structure includes the possibility to spread it over two years, especially to accommodate young professionals.

The programme offers in-depth training in all aspects of nuclear engineering and its economic and social implications based on a profound scientific basis. Students should be able to develop sufficient maturity to be able to develop, implement and monitor technical and scientific innovations in the nuclear field.

Curriculum: programme outcomes and learning outcomes

As mentioned in the faculty's self-evaluation report, the aim of the BNEN programme is to provide students with the skills and the scientific and technical background necessary to carry out duties with a high level of responsibility to ensure the safe and economic operation of nuclear power plants, the regulation and control of nuclear installations, the design of new nuclear systems, and, more broadly, to contribute to developing and maintaining high-level nuclear skills in Belgium and abroad.

The current curriculum of the programme covers these ambitions.

Reflection is currently underway within the Teaching Committee to broaden the programme to evolve eventually towards a BNEN 2.0 programme, to take into account new needs in the nuclear industry, such as decommissioning and dismantling, waste management, etc.

Programme implementation

The programme is organised into modules containing theoretical courses, exercises/laboratory sessions/visits, and hours for additional personal work (readings etc.). It is not a semester-based programme but has a one year structure.

There is a well organised brochure available in which the learning outcomes and the course content for each module is clearly stipulated.

The number of credits per module is also mentioned in accordance with the European Credit Transfer System. The 60-credit programme consists of: 31 credits for compulsory modules, 9 credits for elective modules, 20 credits for a master's thesis.

The compulsory modules contain the subjects related to introduction to nuclear energy, introduction to nuclear physics and nuclear measurements, nuclear materials, nuclear fuel cycle, radiation protection, nuclear thermal hydraulics, nuclear reactor theory, and safety of nuclear power plants.

The six elective modules are mostly advanced courses on the previous topics, of which three modules must be taken by the students. The subjects are: advanced nuclear reactor physics and technology, advanced nuclear materials, advanced courses of the nuclear fuel cycle, advanced radiation protection ecology, nuclear and radiological risk governance, advanced course elective topic.

The master's thesis is a final step in the learning process. Its aim is to provide training to independently perform scientific research in the nuclear domain.

The syllabus is available in English. It is clear and structured into teaching units and course module contents.

On-the-job training

The internship is a possibility to perform the master's thesis. Another possibility for internship is through an advanced course on an elective topic that is selected and accepted as an elective module in Belgium or abroad. The number of hours dedicated to such an internship is 90 hours and counts for 3 ECTS credits.

Research activities

Most courses include Exercises, Laboratory sessions and/or Seminars (E-L-S) at the SCK-research centre or elsewhere. Laboratory sessions and seminar attendance are compulsory. The academic head of the course decides on the reporting (number of pages, deadline) as well as on the weight of the E-L-S in the final quotation of the overall course.

Research skills are explicitly strengthened in the master's thesis, which accounts for about 33% of the student workload or about 13 to 14 weeks of the effective workload. Thesis proposals come from academic promoters, the SCK CEN research centre, or in case the student is a young professional, she/he can propose a subject from their company, provided the work is significantly different from their daily duties and is performed in the perspective of academic work.

Training for an international multicultural context
All courses are taught in English, as students can come from all over the world, although most are from the European Union. This automatically creates a multicultural context. For foreign candidates to take this advanced master's programme, the background requirements can be dissuasive.
While there is frequent incoming mobility, there is little outgoing mobility. Outgoing mobility happens occasionally when a student selects an advanced course on an elective topic as elective module for 3 credits, or in the framework of the master's thesis for 20 credits.
The hosting of the foreign students is mostly organised and accommodated at the SCK CEN research centre, since it is where all theoretical courses and laboratory sessions take place.

Sustainable development, social responsibility and ethics
The compulsory course on 'Radiation protection' and the elective course on 'Nuclear and radiological risk governance' have learning outcomes dedicated to this topic. The learning outcomes of these studies are assessed in oral and written examinations.
There is also a specific lecture in the course "Introduction to nuclear energy" about nuclear energy and sustainable development.

Educational engineering
Lectures with contact hours for theory come first (~ 43% of time spent), followed by exercises/laboratory sessions and visits (~16%) and additional personal work (~8%). Additionally, the master's thesis accounts for about 33% of the student workload.
During the COVID pandemic, there was a lot of online teaching. This experience showed that classroom teaching is the preferred teaching method for most of the lecture courses. Changes to find a proper balance between online teaching versus classroom teaching is ongoing.
The PowerPoint presentations and associated documents of all courses are available for the students on the BNEN website.
A portion of the programme is given by professionals from the nuclear industry.

Student life
The student population consists of full-time students and young professionals.
For the students from abroad, there is accommodation at the SCK CEN site, where all lectures, exercises and laboratory sessions take place.
A student representative of the nuclear engineering students acts as contact person for the BNEN secretariat and the instructors to set exam dates, etc. There is good interaction between the students and their lecturers.
Students mention that the exam planning is partly done by the students and that there is a delay between exams and results which is too long. Students mention that for some courses, the credits awarded are not in line with the workload.

Student monitoring / failure management
Since the BNEN programme is an advanced master's programme, most students acquired the prerequisite knowledge, skills and competencies in mathematics, thermodynamics, fluid mechanics, heat transfer, general physics, chemistry and electromagnetics in their initial master's programme in engineering science.
All students are very motivated for this advanced master's programme.
Incoming students who do not comply with the necessary prerequisites must follow a preparatory programme before entering the BNEN programme, so as to further strengthen several general skills needed for the BNEN programme.
As a result, the failure rate is low, and dropout is often due to finding a job outside the nuclear sector. Most graduate students already have a job or find a job in the nuclear industry.

Assessment of results

All BNEN courses are described in the brochure of the advanced master's in Nuclear Engineering with their learning outcomes and their content. There is also a curriculum mapping matrix to demonstrate that the outcome for general skills, general scientific skills and discipline-specific skills are well covered throughout the different courses of the programme.

The method for evaluating the learning outcomes for each course is mentioned in the brochure. The deliberation rules with criteria for passing course units and to obtain the master's degree in Nuclear Engineering and level of achievement are also clearly mentioned.

Analysis summary – Advanced Master of Nuclear Engineering

Strength

- Very strong programme;
- Combination of lectures given by experts from the academic world and from the industry;
- Possibilities for the students to visit and to do their master's thesis in a nuclear facility;
- Very strong motivation of the students who join the programme.

Weaknesses

- Limited possibilities for international experience, which means that the benefit of a European Nuclear Education Network label is not possible;
- Starting the master's thesis before the start of the basic lectures;
- For some courses, credits awarded are not in line with the workload;
- Exam organisation and feedback: the exam planning is partly done by the students and there is a delay between exams and results which is too long;
- The title of the elective course is not clearly defined;
- Insufficient use of the dedicated programme platform: schedule, messages, information exchanges, grades, exam results are not found on this tool.

Risks

- Uncertainty about the European nuclear market and on the Belgian policy on nuclear energy;
- Retirement of key members;
- A very steep increase of the number of students compromises the organisation of the programme.

Opportunity

- Retirement of key members;
- Increase awareness about the need for diverse and alternative energy sources for Europe.

Master of Engineering: Computer Science

The programme (120 ECTS) is built around a mandatory core (46 ECTS), 18 of which are dependent on the bachelor's track of the incoming students. In 2020-2021, 34% of the incoming students for the Dutch-language programme came from the bachelor's programme in Informatics of KU Leuven, 47% came from the Bachelor of Engineering of KU Leuven. 19% of the students came from a master's in industrial engineering and from bachelor's programmes in informatics.
The programme is scheduled in two academic years, divided into four semesters.
The master's programme in Dutch language offers 6 specialisation options in Distributed Systems, Secure Software, Artificial Intelligence, Software Engineering, Human-Computer Interaction, and Computational Informatics which students can choose from (36 ECTS credits).
An English-language variant (started in 2014-2015) copies the Dutch programme, but only offers 2 specialisations in Artificial Intelligence and Secure Software. Around 10% of the students taking the English-language programme are mainly students from European and non-European countries. The number of Belgian students remains marginal.
The master's thesis (24 ECTS) and general education courses (8-14 ECTS) covering a wide variety of topics, complete the programme.
The compulsory courses of the programme cover the essential fields of computer science, with a special focus on software development (including two project courses).
Since 2016, there has been a large increase in student numbers, both in the Dutch (+34%, from 230 to 308 students) and in the English-language (+83%, from 18 to 33 students) programme.
Since 2017, the Industrial Advisory Board has evaluated and given recommendations for programme content (including soft skills). The 17 members of the Industrial Advisory Board are representatives from large and small Belgian companies from several industries. This board also evaluates the impact of online organisation on education and companies.

Curriculum: programme outcomes and learning outcomes

The Faculty of Engineering Science adopted the Academic Skills and Quality Assurance framework of the university. For Computer Science, a matrix of 30 programme outcomes versus academic activities is used to indicate whether the skills are covered in the course and whether they are evaluated.
The programme outcomes are not described in the course description but in the programme guide.

Programme implementation

The programme options (Distributed Systems, Secure Software, Artificial Intelligence, Software Engineering, Human-Computer Interaction, and Computational Informatics) are supported by the research activities at the Department of Computer Science. Courses are therefore taught by experts in the field.
The master's thesis (24 ECTS), usually with a topic in the field of specialisation, is typically started at the beginning of the second academic year. Most students choose a thesis topic defined by one of the research groups of the Department of Computer Science. Collaborations with industrial partners are also possible.
The general education courses (8-14 ECTS) cover a wide variety of topics. The main goal is to give the students the opportunity to expand their intellectual horizon beyond computer science and engineering. Although it is stated that students are encouraged to do an internship or take up an entrepreneurial project, the students observe a limited promotion of international experience (internships, Erasmus+, etc.)
Since 2016, two new courses have been offered: Principles of Machine Learning (6 ECTS, compulsory course), AI Ethics and Regulation (4 ECTS credits, optional course). In 2022, the Advanced Algorithms course (3 ECTS) will also be offered to students from the Bachelor of Engineering.

Regarding soft skills, 4 clusters have been identified based on staff and student surveys: self-management and maturity of reasoning and thinking, broad palette of communication skills, project management and project execution skills and, specific skills for an industrial and entrepreneurial context.
Currently, soft skills are covered in a limited way and should be properly implemented including evaluation of the acquired skills. The department foresees enhancing the soft skills dimension of the programme.

The syllabus is available internally and externally. It is updated, and states, for each academic activity, the previous knowledge, the content, the teaching methods, the course material, the number of teaching hours, the number of ECTS credits and the assessment methods.

The Programme Committee includes representatives from the faculty and research staff and from the students. This entity is responsible for the quality of education in a study programme, for the day-to-day organisation and monitoring of programmes and provides advice on policy matters. During the CTI on-site visit, it appeared that communication about the content of the courses do not align with the students' expectations and that there is a long delay between the decision-making and the actions raised by the Programme Committee. The department plans to continue to improve communication to students.

On-the-job training
There are two types of non-compulsory internships: the Industrial Experience (3 ECTS) and the Industrial Internship (6 ECTS). Internships usually take place in the summer period when the students are not taking courses.
Internship opportunities are offered on the student portal, but students are encouraged to actively search for an internship in their fields of interest.
In 2019, the last summer before the pandemic, 51 students did an internship in 42 different companies but the student trade-off between internships and courses remains high.
Other non-academic experience is also encouraged, such as case studies in courses from a non-academic environment in Distributed Systems, Software Architecture and Machine Learning, and a large variety of opportunities in Techstart (KUL incubator), Humasol, Academics for Development (AFD), etc.

Research activities, innovation and entrepreneurship
Most students choose a thesis topic defined by one of the research groups of the Department of Computer Science; collaborations with industrial partners are also possible. The master's thesis is the most prominent part of the programme in which students participate in research and learn research-relevant skills.
The following optional courses related to research activities, innovation and entrepreneurship are offered: Innovation Management and Strategy (6 ECTS), Entrepreneurship in de praktijk / in practice (3 ECTS), Entrepreneurship in practice / service-learning (6 ECTS) and, Project Management (3 ECTS).

Training for an international multicultural context
International experience is encouraged and exchanges with different institutions are possible (EPFL, ETH Zürich, NTNU, Trondheim, Aalto University, etc.). During the CTI on-site visit, it appeared that the number of students with an international experience is low, but no figures were provided.
Improved information and communication have been put in place (Toledo community) in order to double the number of outgoing students (w/o virtual mobility).

Sustainable development, social responsibility and ethics
A new course called AI Ethics & Regulation (4 ECTS, optional course) is offered to students in order to increase their insight in the ethical and legal frameworks that should steer the development and use of artificial intelligence (AI), or more broadly, autonomous and intelligent systems (A/IS).

Educational engineering
In the Master of Computer Science, a significant number of the courses include exercise sessions, lab sessions and/or projects, involving the development of software by the students. The teaching methods are well described in the syllabus.
The Machine Learning: Project course (3 ECTS) is compulsory. The Computer graphics: Project course (3 ECTS) is also offered.
Future changes will be put in place for new teaching methods such as blended learning, video clips, recorded and streamed lectures; student portals for communication; toledo community for announcements from third parties and selection of international students.

Student monitoring / failure management
Student monitoring is implemented via the Cumulative Study Efficiency (CSE) index. A CSE of 100 means that a student has successfully completed every course unit after the first enrolment. In 2019, 59% of the students graduated in the Dutch master's programme with a CSE of 100%.
In the English-language programme, only 17% of the graduating students in 2019 have achieved a CSE of 100%. Because of the lower CSE in the English master's programme/ education, a new staff member was appointed, who will be dedicated to this group of students.
Assessment methods are well defined in the syllabus.

Regarding the student workload, several changes have been put in place:
- Decoupling theory and project in Software Architecture, Machine Learning and Computer graphics, providing more flexibility for students;
- Improving the balance between semesters;
- Indicative overview of the workload of assignments and projects;
- Cooperative attitude of the didactic teams.

There however still exists a lack of coordination between teachers for project work and deadlines.
During the CTI on-site visit, it appeared that the workload for some credits is underestimated, mainly for projects.
The department foresees to continue the monitoring of the workload of students.

Assessment of results
The Programme Evaluation Report for the Dutch programme (2018-2019, response rate: 49 of 117) shows that students are very positive about most elements of the programme, such as the clear structure of the programme and its objectives, clear evaluation criteria, good infrastructure (classrooms, ICT), professional skills, possibilities to gain international experience, guidance for the master's thesis, etc. The general satisfaction is high: 79% of the students agree on the question "In general, I am satisfied with the programme I followed".

The alumni provide testimonials (online) for future students.
In general, the alumni organisation is not very active. Despite efforts, the response rate for surveys remains low for alumni (17%).

Analysis summary – Master of Engineering: Computer Science

Strengths:

- A well-received programme with significant satisfaction from the primary actors (e.g. students, alumni and teaching staff);
- Large increase in student numbers, both in the Dutch (+34%) and in the English-language (+83%) programme;
- Excellent employment rate;
- CTI recommendations taken into account;
- Good participation of students in the Programme Committee.

Weaknesses:

- Soft skills are currently covered in a limited way and should be properly implemented including evaluation of the skills acquired;
- Student workload for projects is underestimated;
- Lack of coordination between professors for project work and deadlines;
- The amount of ECTS credits awarded is not consistent with the workload;
- Communication on course content does not align with the students' expectations;
- Students observe limited promotion of international experience (internships, Erasmus+, etc.). Long delay between the identification of the actions to be carried out and Programme Committee decision-making;
- Alumni community not very active;
- No mention of learning outcomes and the skills in the course description but in the programme guide.

Risks:

- The number of students is growing more rapidly than university or staff can keep up with.

Opportunities:

- Capitalise on the COVID experience to revise the teaching methods (blended learning etc.).

Master of Engineering: Mathematical Engineering

Mathematics is of key importance in almost all aspects in modern life. The Mathematical Engineering (ME) programme aims to provide students with technical skills regarding process control, numerical simulation, data science and AI (Artificial Intelligence), cryptography, and visualisation. It focuses on models, advanced techniques and tools, and thus has a strong engineering view of mathematics, with systemic, modelling and applied perspectives. Due to the Flemish language decree, the programme is offered in both a Dutch and English variant, which features only minor differences. Over the past several years, the programme has grown to an influx of 30-40 students per year for the Dutch-language variant and about 10 for the English-language variant. In its structure, in addition to the compulsory portion and tracks, there are no distinct profiles or specialisations. Instead, students choose a variety of elective courses more or less freely, with few constraints. Overall, Mathematical engineering (ME)is well established in the faculty.

The programme is organised by two departments with a new programme director in 2021. Content is formally and frequently discussed in the regular Programme Committee and Industrial Advisory Board meetings. Adjacent programme interfaces (e.g. computer science, AI

advanced master's, master's in statistics) are also considered with some common teachers. Part of the curriculum concerns training in a realistic industrial or research setting. This typically occurs in the case study, the compulsory project and the master's project, as well as the optional internship. Furthermore, all basic sciences, engineering and technology are integrated in the programme training graduates that are employed in a wide range of sectors in industry, consultancy and academia. ME, with its two language variants, aims to attract both Dutch-speaking students (particularly from KUL's Bachelor of Science in Engineering) and international students. The former guarantees a population that is well suited for the programme, in terms of prior knowledge/skills and being familiar with the KUL's academic culture. Although the programme has a high reputation in academia and industry, there is a lot to gain in terms of visibility (as well as branding and clarity regarding the meaning of Mathematical Engineering). This master's should be positioned in the landscape of other programmes (e.g., computer science, Artificial Intelligence, Cyber security).

Curriculum: programme outcomes and learning outcomes

The ME skills include conducting research and solving problems for real industrial settings. The programme prepares for a variety of sectors, from classic engineering to the high-tech industry, medicine and finance. Students must follow a scientific approach and possess the corresponding non-technical skills (e.g. teamwork, communication, social context and ethics). According to the curriculum mapping matrix (from 2014), the set of programme outcomes is fully covered by the courses/projects in a balanced way. According to a previous CTI recommendation (recommendation 2016/09-11, "Work to define outcomes for graduates that correlate better with professional expectations"), professional skills have been reinforced across the programme. However, taking the student's freedom regarding electives into account, a systematic assessment of the non-technical skills is not warranted (e.g. Programme Outcomes 24-28). Constructive teaching alignment principles could be improved, with refreshed curriculum mapping and analysis.

Programme implementation

The programme's structure, with a clear division into semesters and the awarding of credits for each teaching unit, is compliant with the general principles of the Bologna process. Learner working times could be harmonised for better consistency with the ECTS organisation.
The two-year programme (120 credits) has a flexible architecture in line with the faculty's style, offering a variety of broadening electives. The curriculum contains:

- Core education, including industry-inspired case studies and a project (40-47 credits);
- General interest courses covering non-technical aspects (9-12 credits);
- A master's thesis proposed by internal professors or members from the Industrial Advisory Board (24 credits);
- Technical elective courses to be chosen from different tracks (at least 18 credits);
- Broadening elective courses (large pool of courses offered in other programmes, for a total of 120 credits). As part of the general interest courses, about 10-20% of the students opt to do an internship in a company, in Belgium or abroad.

On-the-job training

As one of the general interest courses, the internship in an industry setting is an elective (3 or 6 credits), opted for by about 10-20% of the students. Also, the compulsory case studies and project courses offered as part of the technical core education are directly inspired by mathematical problems encountered in industry. Finally, about 25% (2019-2020) of the master's thesis projects are proposed by industry, thanks to the active Industrial Advisory Board.

Research activities, innovation and entrepreneurship training
Research skills are spread across and covered by the entire curriculum thanks to top-level academics involved in the teaching. Importantly, the topics offered in the courses align with (and thus also depend on) the specific research fields in which the teaching staff are active. In support and as part of the research activities, the students receive broad theoretical and applied skills contributing to their mathematical 'toolbox' for profiling applied engineers.
Entrepreneurship is taught in three of the general interest courses (with a maximum of 9 credits), and thus serves as an elective within the programme. A specific elective covers Engineering & Entrepreneurship for 6 ECTS. Students are exposed to innovation through the compulsory case studies and project courses, as well as in the master's thesis project, particularly regarding the topics proposed by industry. Furthermore, there is a strong link to innovation in research as the master's programme is supported by high-quality research that has led to several spin-off companies. However, it is sometimes difficult for the rest of the curriculum to keep up with trends in the field.

Training for an international multicultural context
Since the English-language variant was launched in 2014, the programme has seen an annual influx of about a dozen international students. Teaching quality is uniform; almost all variant courses are taught by the same teacher. The nature of the programme allows the two student communities (domestic and international) to mix. A single English taught programme is planned, Flemish language decree permitting.

Sustainable development, social responsibility and ethics
Some non-technical and cross-disciplinary skills (contained e.g. in Programme Outcomes 27 and 28) are covered by the programme, even if some formality is missing in course intended learning outcomes for enhanced visibility and skill profiling. Ethics and social issues could be more formally covered by the programme for all students, as project management is only a general interest course and competes against the 9 to 12 credits to select among 15 courses of 3 to 6 ECTS credits.

Educational engineering
In the ME programme, students experience a wide variety of project-based learning methods, covering most phases of engineering projects, strengthening transferable problem-solving skills. Importantly, the effect of these teaching methods is amplified by the highly committed teaching staff (including teaching assistants). It should be noted that the workload for students is considered heavy, and unequally distributed over the semesters. Partially related to this, teachers also have a heavy workload, which presents a risk particularly if the programme continues to grow in the near future.
By design, the curriculum offers an adequate mix of theory, practice, innovation and projects. The learning experience is further strengthened by the involvement of representatives from industry (through the Industrial Advisory Board). Also, the students experience a good mix of face-to-face teaching, group work and individual study. According to a previous CTI recommendation (recommendation 2016/09-11, to "raise student awareness about the needs and context of their future careers"), industrial presence is enhanced, e.g. thanks to panel discussions with industrial speakers, case studies and projects.

Student monitoring / failure management
Students are guided via well-distributed responsibilities, i.e. ombudspersons, programme director, study counsellor, exchange coordinator, thesis coordinator.
The student workload is rather heavy and demanding and needs to be harmonize across the semesters.

Since the English-language variant of the programme was launched in 2014, around 10 international students have been enrolled in the programme each year. The study success of the lateral-entry students in the English-language variant is significantly lower. This is mainly attributed to the non-optimal prior knowledge/skills, and to the fact that it takes time to get used to KUL's academic culture. To address this problem, 'Capita Selecta' is used as a preparatory course tailored to the international students. The co-existence of two language variants occasionally causes confusion for the students and increases the workload of the teaching staff.

Assessment of results
The programme uses a balanced and adequate mixture of assessment techniques, including written exams, oral exams, as well as presentations and written reports for individual and group assignments. As a result, the technical skills are adequately assessed. However, as noted earlier, the coverage and assessment of the non-technical skills (Programme Outcomes 24-28) appears less formal and structured, which implies vulnerability in the long term, e.g. certain elements may be dropped over time after staff changes take place.

Analysis summary – Master of Engineering: Mathematical Engineering

Strengths:
- Strong engineering view of mathematics, with applied perspectives;
- Established programme in the faculty;
- Highly committed teaching staff including teaching assistants;
- Good reputation of the programme in the industry (but not well known enough);
- Diversity of graduate careers, from academia to industry and entrepreneurship;
- Several courses supported by project-based learning covering most phases of engineering projects, strengthening transferable problem-solving skills;
- Flexible curriculum architecture in line with the faculty curriculum style, incl. a pool of broadening electives;
- Broad basic and applied skills with a toolbox of mathematical tools.

Weaknesses:
- High and imbalanced distribution of student learning workload within semesters;
- Insufficient cross-disciplinary skills and project management programme outcomes assessment;
- Heavier staff workload due to language differentiation for courses;
- Weak student and professor female gender representation and lack of vision, strategy and actions for improvement;
- The possibilities of the more specialised courses strongly depend on the availability and individual expertise of department professors.

Risks:
- Unclear programme positioning among other local master's programmes in the future (e.g. in Artificial Intelligence, cybersecurity, statistics);
- Increased staff workload if student enrolment increases (teaching duties & master's thesis tutoring).

Opportunities:

- Integrate and coordinate non-technical skills in course syllabi and teaching and learning activities more completely;
- Reinforce interdisciplinary project-based learning with greater teamwork and industrial stakeholder involvement and/or other master's programmes;
- Actively take actions to even out and/or reduce the student workload thanks to monitoring of notional crediting and learning outcomes;
- Put an effort on external visibility if the programme aims to expand its international influx;
- Stimulate alumni network activities with a view to improve the programme and community building.

Advanced Master of Artificial Intelligence

This programme is an advanced master's programme of one year which qualifying students can take after a regular master's degree or an approved 4-year bachelor's programme. It has been in existence for many years, but this is the first time it is being evaluated by CTI. The programme has three variants: Engineering and Computer Science (ECS), Speech and Language Technology (SLT) and Big Data Analytics (BDA). The programme is provided in English only.
It is a multidisciplinary programme in which seven faculties in the university participate.

The programme creates experts in artificial intelligence, researchers, problem solvers and designers. This advanced master's course provides students with advanced knowledge and expertise in the artificial intelligence (AI) field and an even better preparedness for a career in academia or industry. A good mix of theory and practice gives students excellent problem-solving skills.
The programme consists of introductory courses, a programming component, a set of mandatory advanced courses, optional courses and a 15-credit master's thesis. There is laudable emphasis on ethics and the AI debate.
There are opportunities for internships, but, by and large, students make very little use of them, even if more and more students choose this elective course. In a programme of just one year, there is not much room for such flexibility.
In their master's thesis project, students become involved in the research projects carried out in the department, or sometimes in industrial locations nearby. Given the short duration of the programme, this is often the only involvement in research for the students.
The department places considerable emphasis on ethics and social responsibility and we saw evidence of some projects with sustainability as a theme. Ethics is important in this field because AI can be a powerful tool, both for good and for evil. Most students graduate with a job offer (or even a signed contract) in hand. Although we did not observe much activity on the department's part to bring students to the job market, the AI market space is hot enough that all students find work almost immediately.

The one-year Advanced Master in Artificial Intelligence is a solid programme offered by an expert staff. Students are satisfied by the quality and delivery of the programme, although they are seeing the first signs of staff shortages given the steadily increasing student numbers. The three specialisations each address a societal need which shows by the fact that graduates find immediate employment. The emphasis placed on ethics and artificial intelligence is laudable.

Analysis summary – Advanced Master of Science in Artificial Intelligence

Strengths

- Interdisciplinary programme that is well recognised around the world;
- Attracts very good students from all over the world;
- Strong researchers as teaching staff;
- Strong emphasis on ethics.

Weaknesses

- Students need to be kept extremely aware of the sensitivity of the data they manage and the security measures needed to maintain data privacy;
- Lack of programming and/or mathematical skills can create problems.

Opportunities

N/A.

Risks

- Many local and foreign students with diverse backgrounds create a challenge for integration into the programme and obtaining successful outcomes;
- The number of students is growing more rapidly than university or staff can keep up with.

Master of Engineering: Chemical Engineering

The Master of Chemical Engineering programme, the largest in Belgium with about 60 graduates every year, is built around a core curriculum, specialisation courses and general courses fostering non-technical skills, designed to prepare future chemical engineers to tackle the major challenges the industry faces.

The core curriculum, mostly covered during the first year, builds on the knowledge acquired during the bachelor's training and covers the fundamentals of chemical engineering focusing both on traditional and emerging new trends. During their second year, the students choose one of three specialisations: product, process or environmental engineering and focus on their master's thesis with topics assigned out of a pre-selection from a comprehensive list of relevant research/industrial topics.

Students earn a total of 120 ECTS credits for the two years.

While most European chemical engineering programmes focus on process-oriented petroleum base training, KU Leuven deliberately introduced a product-oriented approach as well as an environment-focused orientation.

The education students receive has clearly outlined competencies and skills. It is well aligned with the demand of local employers, who seem to appreciate the students they hire from this programme for their breadth of scientific and technical knowledge, but mostly for their ability to tackle unknown challenges and step out of their comfort zone. Most students find their first job before graduating. Although there are opportunities for accessing the international job market, students usually seek and find jobs in Belgium.

The programme is managed by the Programme Committee, led by the programme director, and composed of all internal stakeholders, including teaching staff, teaching assistants and student representatives, and meets every month. This mechanism seems to operate efficiently due to excellent relationships and trust across all stakeholders. The involvement of alumni in the Programme Committee could be strengthened in the future.

There are numerous ties and exchanges with the industrial world, through industrial guest lecturers, internships, company visits, industrial projects/master's thesis, industry funded research programmes, and the industrial advisory board, thus ensuring continuous adaptation of the programme to industrial and social trends and needs. The department was the first to establish an Industrial Advisory Board in 2004 that meets twice a year. In addition to reviewing the programme, the Industrial Advisory Board ensures the programme's correlation with needs and identifies gaps, as exemplified by the recent organisation of a summer course in data analytics which is currently under evaluation to integrate the programme as an elective course.
A meeting held once a year with the department head and all teaching staff is where major strategic decisions regarding the programme are made.
Despite a low response rate (39%) the results of the survey conducted in 2018-2019 on the quality of the programme are quite positive overall.
The renewal of the teaching staff with 5 new professors joining the team over the last 5 years, for a total of 15 professors, with a good gender balance (male/female ratio of 1.5) is a strong point of this master's programme.

Curriculum: programme outcomes and learning outcomes
Targeted skills are clearly defined with 29 specific programme outcomes using the Academic Skills and Quality Assurance system. They are available on the programme website. A curriculum mapping is also available and delineates how the different courses contribute to achieving the various programme outcomes both qualitatively and quantitatively.
The learning outcomes at the course level are described in the course description. They are updated and checked regularly by the Programme Committee.

Programme implementation
The Master of Chemical Engineering is composed of a mandatory package of common core courses (69 ECTS credits, 57 ECTS credits in M1 and 12 ECTS credits in M2) that cover the fundamentals of chemical engineering. This core training is completed with 18 ECTS specialisation credits that can be achieved by choosing out of three possible options corresponding to the three research divisions of the department, namely, reactor engineering, product engineering and environmental engineering.
Courses of general interest such as social sciences, economics, etc. organised by other faculties account for 9 ECTS credits distributed across M1 and M2 (with 3 ECTS credits devoted to a religion course). Finally, the master's thesis accounts for 24 ECTS credits in M2.

On-the-job training
The Master of Chemical Engineering provides several opportunities for hands-on industrial experience through internships, industrial projects, or master's thesis topics (20% of the master's theses are done in collaboration with industry).
The theoretical courses are well balanced with industrial projects, industrial site visits (although these were more difficult to organise during the pandemic), internships and master's thesis work (research or industrial based) that enable the students to acquire on-the-job training.
The projects performed in teams of 5-6 students on a real industrial issue are particularly interesting. Besides the real-life technical challenge, they provide students with a great opportunity for teamwork and soft skills training.
Although not mandatory, 50% of the students choose to do a summer internship between M1 and M2 and are very satisfied with the experience. Despite the fact that the duration of the internship is rather short (6 weeks), this seems to be enough to achieve the targeted goals and often leads to a job offer.

Research activities, innovation and entrepreneurship training

The programme is embedded in the department research areas. As such, the students benefit from state of the art teaching content and equipment. The recently added Chemical Engineering for Human Health course offers such an example.

Students can choose their master's thesis topics in relation to one of the department's active research fields and thus fully evaluate whether pursuing a PhD thesis is of interest to them. 10% of the students choose to pursue a PhD within the Chemical Engineering Department.

Research and innovation is clearly an integral part of the curriculum through close contact with research activities, both academic and industrial, during master's thesis project work.

Entrepreneurship courses are available to the students although it is unclear how much they benefit from them. This is the only area that was pointed out as one that could be improved by employers. The question of how to best address it, through courses and/or alumni relevant experience is open.

Training for an international multicultural context

Students of the Master of Chemical Engineering are exposed to a diverse multicultural environment thanks to exchange programmes, such as Athens or Erasmus+, and dual/joint degree programmes, as well as international students who join the programme. These exchanges are facilitated by the fact that the master's is taught in English. The programme has recently improved the recruitment process as well as the on-boarding of international students through the assignment of a buddy.

Despite positive feedback from students who benefited from an international experience, outbound mobility remains rather low. The reasons behind these numbers should be analysed and obstacles alleviated.

Also worth noting is the highly international teaching staff comprising 8 Belgian professors and 7 international professors from Brazil, China, Germany, Turkey, the USA, which certainly greatly contributes to an international multicultural context.

Sustainable development, social responsibility and ethics

Every course in the master's programme insists on environmental aspects, so that even students not choosing the environmental option, are often exposed to the notion of sustainability and circular economy. The intent is to have students keep the social and economic perspective in mind, once translating technical solutions into practice.

Safety aspects are considered seriously as exemplified by the safety training of the students before starting any lab work.

The 3 ECTS credits dedicated to the religion course could perhaps be allocated to social responsibility and ethics, which would be more relevant for the training programme, and more appropriate for a group of students from an increasingly diverse background.

Educational engineering

Teaching methods offer a good blend of traditional courses completed with exercise or laboratory sessions, project group work, and master's thesis work. The ratio between theoretical courses and practical/hands-on work is 63% vs. 37%.

A strong emphasis is put on developing problem-solving skills, as exemplified by the Design Project (5 ECTS credits) offered in M1 and completing the Problem Solving & Design course (9 ECTS credits) offered at the bachelor's level. This problem-solving ability was highlighted as a strong point by industrial employers.

Two courses, Chemical Process Design and Management Challenges in the Chemical Industry are taught by external industrial guest lecturers.

The students can enjoy state of the art facilities and the use of advanced technologies to promote learning (remote interactive platforms, augmented reality, etc.).

Student life
Student associations and activities (cultural, sports, etc.) are available.

Student monitoring / failure management
The programme has nearly no dropouts and 80% of the students get their degrees within 2 years. The rather small cohort size along with the great relationships between the students and teaching staff are certainly responsible for these very good results. Student counselling and study support are available.
Individual study programmes need to be approved by the programme director. In the case of incoming master's students in chemical engineering technology, the elective courses are replaced by some fundamental science courses from the bachelor's programme.

Assessment of results
Assessment methods are well defined for all the courses and so are the criteria for getting the degree. It has been reported that feedback regarding soft skills in particular, could be conveyed a little earlier to make it fully useful.

Analysis summary – Master of Engineering: Chemical Engineering

Strengths:
- Quality of the programme: broad and strong technical basis;
- Dedicated and approachable teaching staff and programme director;
- Excellent employability rate;
- Strong ties with industry: Industrial Advisory Board meets twice a year;
- Diverse teaching staff (gender balance and international backgrounds);
- International student recruitment improved (interviews, mandatory GRE test, assignment of a buddy).

Weaknesses:
- Formalisation of relations with alumni, already pointed out in the 2016 CTI evaluation, still to be improved;
- Importance of soft skills not clearly delineated in the programme;
- Redundancies/overlaps noted for the entire bachelor's/master's programme: this could free time for more value-added activities, e.g., providing better visibility about the different engineering options available through guest lectures, industry visits, etc.

Risks:
- N/A.

Opportunities:
- Develop teaching evaluation, e.g., with respect to soft skills;
- Leverage the alumni network;
- Cross-fertilisation with other disciplines, e.g., bioengineering;
- Leverage the yearly meetings to anticipate social changes and needs;
- Strengthen relations with the pharmaceutical industry.

Master of Engineering: Materials Engineering

The Master of Materials Engineering (MME) programme is aimed at training students in materials designing, making, using and recycling. It covers a broad scope of materials (metals, ceramics, polymers, composites) which can be useful in numerous applications (from health to aircraft industries) and are of a very high social importance.
The programme is based on a core of mandatory scientific and technological courses (60 ECTS) on generic knowledge in methodology, material families, design and applications, including sustainable materials management. Students can build their own pathway by selecting a specific material family/application (12 ECTS), a specific professional environment (research, production or management; 12 ECTS), and elective courses (9 ECTS). A mandatory course on religion is worth 3 ECTS credits. They are all trained in research and integrated in an excellent research environment, by doing a master's thesis in KUL labs (24 ECTS).
In parallel, a dual master's degree on sustainable materials (SUMA) is offered in partnership with European universities: Trento (Italy), Leoben (Austria), Milano (Italy) and Grenoble (France). For financial reasons, most students choose to do the M1 in one of the partner universities (and to pay the fees there) and come to KUL to do the M2. The M2 programme (60 ECTS) contains courses in innovation and entrepreneurship (30 ECTS), an internship (6 ECTS credits) and a master's thesis with industrial application (24 ECTS). Interestingly, the M1 has a strong emphasis on sustainability, eco-design, recycling and circular economics. This could inspire future changes to the MME programme.
The recommendations issued by CTI in 2016 are very seriously taken into consideration, but the number of local students recruited into the MME is still a problem although the programme is very timely and of excellent scientific quality and all stakeholders are aware of the problem. The lack of attractiveness of this interesting programme is probably due to a poorly adapted promotion that focuses on the programme content and materials science rather than the huge social issues and challenges of materials engineering, as well as the need for engineers in this area.
In 2021, 37 students were registered in MME (17 in year 1 and 20 in year 2). The programme, which amounts to 120 ECTS, is taught in English and Dutch. 44 students are registered in a SUMA dual degree (2 in year 1 and 42 in year 2). The programme, which amounts to 120 ECTS, is taught in English.
Developing new and high-performance materials is a goal this programme, as a response to the needs of various application sectors (health, aeronautics, automotive, building and construction, etc.). Facing the specific constraints/criteria for designing and producing even more high-performance and functional materials is a scientific and technical challenge and a very dynamic sector of innovation.
The need for materials engineers is clearly identified by many Belgian and international companies, such as the ones involved in the Industrial Advisory Committee. Due to the close ties with research and the high scientific level, the MME programme is quite often followed by a PhD track, followed by positions as academics or in R&D organisations. Jobs in materials production and management and entrepreneurship are also targeted by the programme.

Curriculum: programme outcomes and learning outcomes

The curriculum is available online and is very clear on the learning outcomes for each course, including the projects and internships. Organisation of the programme and the course units is consistent with targeted skills and the diverse student backgrounds.
The emphasis is mainly placed on science and techniques in the field of specialisation.
Prerequisites in basic sciences or in materials were acquired at the bachelor's level for local students and bridging courses are offered to foreign students, depending on their background. Up to 27 ECTS credits can be delivered for these courses (fundamentals for materials science, mathematical materials science, polymers and composites). They replace electives for up to 18 ECTS credits within the regular master's program.

Courses are taught in English for most of the students. Soft skills can be developed in 2 mandatory courses devoted to project work, in the internships for the 75% students that take 2 of 3 elective professional profile packages (PPP), in elective general interest courses (up to 6 ECTS) and during the master's thesis. In each PPP, a course is devoted to soft skills (Safety for Production, Scientific Writing for Research and Project management for Management). Globally, little space is devoted to economics.
The syllabus is fully consistent with the Bologna process.
It includes the teaching methods and corresponding contact time but the estimated time of personal student work is missing. The evaluation method and expected outcomes for the validation of ECTS credits for each UE are presented. Each course component is comprehensively and fully described.

Programme implementation
The programme was implemented according to KUL and Flemish regulations. The hosting department and staff have strong industrial networks. Discovery and integration in a professional context is well organised in the programme, in relation to the student professional pathway. Internships in companies are mandatory for 2 professional pathways, and the students of the other one (research) are immersed in a research environment during the master's thesis. 75% of the students do a 6 week minimum duration internship in industry. Internship management and assignment rules could be improved towards more transparency and equity.
Interestingly, some foreign students had previous positions in companies and applied for the programme to gain the required knowledge. They are highly satisfied with the programme and there is a good opportunity to make other students benefit from their expertise within group work.

Research activities, innovation and entrepreneurship training
Research activities are one of the strengths of the programme and represent an efficient support to build a modern programme oriented towards state-of-the-art materials engineering, with a focus on both fundamentals and applications. The teachers staff members are involved in high-level research in materials and the group has a good international visibility that contributes to the programme's international appeal. The proximity of the materials engineering laboratory creates a very favourable environment for the students, even though renovations have been underway for a long time.
Students are trained to conduct research through the master's thesis (24 ECTS) carried out within the laboratory of the Materials Department. They are all very proud of their ongoing master's thesis and of the newly acquired skills. Supervision by the teaching staff is effective and appreciated.
In addition, students targeting a research profile can choose the research professional pathway.
Two elective courses on innovation and entrepreneurship are offered as part of general education courses. 10% of graduates become entrepreneurs.

Training for an international multicultural context
The internationalisation of both the teaching staff and the students is high (39% of staff from abroad, 76 % of foreign students from various countries), and thus the students are trained to work (through tutorials and projects) in a multicultural environment and to develop linguistic skills. Working together in this international environment is considered very natural by teachers and students.
Foreign students are very proud of being at KUL after a highly selective recruitment process. They are very satisfied with the programme and with the bridging lectures, which are very useful for them. Overall, they have very positive feedback that could benefit the promotion of the programme.
For outgoing mobility, MME students can take advantage of dual degrees with KTH Stockholm and UC Leuven and Erasmus+ exchanges in Denmark, France, Sweden, Switzerland.
In the SUMA program, one-year abroad is required (but concerns the limited number of students enrolled in M1).

Sustainable development, social responsibility and ethics
Regarding the expected outcomes for the MME programme, sustainability and social responsibility are evoked in ACQUA7. This is not the case for ethics.
The level of expected outcomes is not ambitious enough or adapted to current industrial and societal needs. For example, the programme's current expectation is that "The graduate has an eye for sustainability issues in the production, use and recycling of materials", whereas, for modern engineers in materials, strong skills in materials eco-design and sustainable production are a necessity.
Sustainable development is not sufficiently emphasised in the programme in terms of current issues in materials. A mandatory course on Sustainable Materials Management (3 ECTS) is offered as well as an elective course on eco-design and life cycle engineering (3 ECTS).
Safety is introduced in a dedicated course (3 ECTS) in the production-oriented pathway.
Ethics is not introduced in courses.
In the mandatory project, sustainability, social responsibility and ethics are not expected outcomes, according to the syllabus.

Educational engineering
The students are exposed to various conventional teaching methods (courses, tutorials, group work, projects) on materials, their application and design. A project (2 x 3 ECTS) is mandatory but it is unclear if industrial case studies are considered. The teaching staff appreciates the cultural diversity of the students, and they seem comfortable in managing the huge heterogeneity of their profiles.

Student life
The atmosphere in the Materials Department appears good; both the teaching staff and students have a constructive attitude. Students enjoy life in a small department, with events every month. Even during the pandemic, students could always reach a staff member for guidance. Students enjoy the programmes, and SUMA and MME students are perfectly mixed.

Student monitoring / failure management
The graduation rate within 2 years decreased from 90 % in 2017 to 50 % in 2019, due to the increasing number of foreign students.
A group in charge of education, student work and recruitment was recently created.
Students are generally satisfied with monitoring and guidance. However, they would like better management and information on internships. Some of the "COVID generation", deplored the loss of direct contact but all appreciated the online interactions and availability of most teaching staff members to support them. Some did not appreciate the assignment of the master's theses by an algorithm and the fact that some topics that they had found by themselves were assigned to other students. Considering the low number of students in the second year, assignment based on collective consensus and transparent rules could be feasible.

Assessment of results
The method of assessment and the conditions for awarding the degree are clearly described.
Student dropout is monitored. It represents about 7% of MME students and is mainly linked to foreign students leaving due to financial aspects when the graduation time exceeds 2 years (end of scholarships for SUMA or fees for MME students).
Belgian bachelor's students are accepted into MME or SUMA without a selection process. A very selective process is applied to select foreign students. The number of students recruited in the MME has increased in the last 4 years but remains low, with only 17 students in M1 in 2021. There are currently a total of 37 students in the programme. In comparison, the SUMA has about 63

students (in 2021). Overall, student diversity is high, with 76% international students and 28% female students (which could still be improved).
The MME is offered both in Dutch and in English. Fewer and fewer students have been enrolling in the Dutch programme (only 2 in M1 and 1 in M2 in 2021-22), which raises the question of the necessity to maintain this programme that generates a heavy teaching workload for Dutch-speaking teaching staff members.

Analysis summary – Master of Engineering: Materials Engineering

Strengths:

- Strong focus on both research and industry;
- The diversity (internationalisation) of students and teaching staff;
- Positioning on a very important topic in the current social context (environmental and energy transitions);
- The interesting organisation of the programme with 3 complementary professional pathways;
- Mandatory internships in 2 elective packages;
- Staff members are attentive to and well integrate international students.

Weaknesses:

- Attractiveness of the MME for local students;
- Better balance of recruitment in Master 1 and in Master 2 in the SUMA dual degree;
- Ambition of the expected outcomes on sustainability is too low in comparison with current social and industrial needs for materials;
- The length of time to graduate and the dropout rate of international students.

Risks:

- Lack of sustainability of the programme due to a reduced inflow of local students;
- Additional workload to offer a master's programme in Dutch for a limited number of students
- Attractiveness of the SUMA programme, where students mainly register at a partner university.

Opportunities:

- Better communicate on the social and environmental issues linked to materials engineering and draw inspiration from SUMA (oriented towards sustainable materials) to increase the appeal of MME for local bachelor's students;
- Find more synergies with the master's in nanoscience and in biomedical technology;
- Take advantage of reforms to the bachelor's programme to increase the visibility of the training programme.

Advanced Master of Safety Engineering

About 25 to 30 students are enrolled every year in the master's programme in safety engineering but only about 15 students are recruited and graduate each year. The difference between the figures is due to the fact that some of the students are working professionals who take 2 to 3 years to complete the programme. It is a one-year programme on paper but flexibility allows completion on an extended timeframe. The majority of the admitted students hold a master's degree (in engineering science, engineering technology, bioscience engineering, etc.) with the exception of 4 to 5 students with only a bachelor's degree but with professional experience. About 40% of the students are non-Belgian, and about 25% are women. The programme is built around a common core and 2 options: Process Safety and Prevention. It is partnered by Essenscia (the Belgian federation for the chemical and life science industry) which contributes money through the Chair of Safety Engineering. Despite this support, the programme requires high tuition fees as it is not subsidised by the Ministry of Education.

The Advanced Master of Safety Engineering is managed by a dedicated Programme Committee which meets twice a semester. It benefits from regular input from Essenscia and the Industrial Advisory Board shared with the chemical engineering programme. An annual meeting of all the full-time teaching staff members strengthens strategic thinking. Conclusions from these meetings have to be endorsed by the Programme Committee. A new course called "Cognitive & Organizational Ergonomics" started in 2018-2019 in line with one of the 2016 CTI recommendations to develop student awareness around "the role of human behaviour in safety". Some overlapping course content has been detected which needs to be overcome. Based on alumni feedback, fire safety might be better covered as well as some courses related to explosion. To deal with these kinds of issues and take into account new trends in the field of safety, the programme will be revised with an implementation targeted for 2023-2024. In addition, the programme management needs to anticipate the replacement of retiring teaching staff members in the coming years in order to ensure the sustainability of this programme.

Curriculum: programme outcomes and learning outcomes

Programme outcomes are formulated within the Academic Skills & Quality Assurance framework of the Faculty of Engineering Science: 5 general skills, 7 knowledge & insight skills, 8 skills competencies and 3 attitude skills are identified in the "Programme Outcomes Annex". However this is not fully aligned with the skills matrix (Curriculum Mapping Annex) which refers to 6 skills in relation to specific knowledge in the field of safety, 5 skills in relation to skills & abilities and 3 skills in relation to attitudes. The programme revision targeted in 2023-2024 should be an opportunity to align programme outcomes and matrix skills. Based on students' and alumni feedback, the master's thesis should start earlier in the year in order to better balance the workload.
The syllabus is available internally and externally. It is updated and states the Learning Outcomes (LO), the number of teaching hours and the number of ECTS credits associated with each academic activity. The students have to validate 60 ECTS to graduate.

Programme implementation

The common core (17 ECTS) is entirely taught in English as well as the Process Safety option (28 ECTS). The Prevention option (28 ECTS) is partly (2/3) taught in English and partly (1/3) taught in Dutch due to the fact that this second option grants the Belgian "Certificaat Preventieadviseurs Niveau 1", which mainly attracts Belgian students. A master's thesis (15 ECTS) completes the curriculum. Of the 28 ECTS for the options, 25 ECTS are mandatory, 3 ECTS are electives for Process Safety, 22 ECTS are mandatory and 6 ECTS are electives for Prevention. Electives are all related to technical topics. The programme's management is working to decrease discrimination between the 2 options and the Prevention Option with 2/3 of the courses taught in English might be more open to non-Belgian students.

On-the- job training
The Industrial Advisory Board, with its 15 professionals from different companies meeting twice a year and the Essenscia organisation input ensure a strong link with the needs of companies in terms of safety and prevention. One-week training courses for working professionals (5 courses from the academic programme taught on a one-week basis) allows exchanges and interactions between these professionals and the students. Of a total of 56 lecturers involved in the programme, 18 are from industry (14 guest lecturers + 4 external experts). Some master's theses are conducted in connection with industry but this should be further stimulated, for instance through a stronger alumni network. Company visits are organised throughout the year.

Research activities
The master's thesis always has strong roots with research. The range of the master's thesis topics is quite impressive (e.g. impact of the passive house concept on fire behaviour, safety and the 4th industrial revolution, safety aspects related to potential radiological issues with geothermal energy plants…).

Training for an international multicultural context
The programme is taught in English with the exception of some specific Belgian legislation aspects necessary to get the "Certificaat Preventieadviseurs Niveau 1". About 40% of the students are non-Belgian, creating an international environment in the programme. Student surveys point out that the programme might better capitalise on this multicultural environment to further develop an international culture. Promotion of the programme has still to be improved in order to attract more European students.

Sustainable development, social responsibility and ethics
Safety and prevention are at the forefront of sustainability, social responsibility and ethics policies in industrial companies. Courses related to risk analysis techniques, prevention policy and safety management systems represent about 1/3 of the common core (6 credits of a total of 17). A new course related to human behaviour (Cognitive & Organizational Ergonomics) started in 2018-2019 in the Prevention option. The safety engineering programme teaching staff delivers several courses in initial master's programmes (e.g. chemical engineering offers 4 electives related to safety, e.g. mechanical engineering offers 2 electives related to safety, e.g. civil engineering & architecture have mandatory courses related to Fire Protection & Building Safety, etc.).

Educational engineering
Besides the master's thesis, teaching methods are mostly in classrooms. Exercises are limited, however lectures are open to a lot of discussions. Soft-skills are mainly evaluated during the master's thesis (quality of the written and oral presentation). Flexibility of the programme needs to be outlined as it allows the students to complete their full training in 1 to 3 years, therefore allowing working professionals to enrol in it. The academic teaching staff is quite diversified, covering a broad range of KUL competencies: chemical / electrical / mechanical / civil engineering, architecture, medicine, psychology, organisation. Results evaluation through peer assessment or by pushing new elements of interaction into the courses might be developed to further assess / strengthen student soft skills.

Student life
Students are well represented in the Programme Committee and questions raised always get an answer with some delay, sometimes due to the number of guest professors and professional experts. All the students praise the facility and the quality of contacts with the teaching staff. Mixing students with working professionals is perceived as very positive by all the stakeholders. Students benefit from a broad and active range of activities and services from the student union (VTK) of the Faculty of Engineering Science and of the KUL in general.

Student monitoring / failure management
An ombudsman is available to support the students when required. Approximately 42% of the students graduate in 1 year. For the rest, who are mainly working professionals, it takes 2 to 3 years to complete. The student dropout rate is high (15% over the 2015-2020 period) mainly due to the master's thesis not being completed because the students found a job before (meaning that the employability of the students is very good) or because international students have to return home after 1 year before fully completing the master's thesis. The master's thesis definitely needs to be started earlier in the year in order to cope with this kind of issue, which is detrimental to all the stakeholders. There is no alumni survey available for this Advanced Master of Safety Engineering, confirming that a dedicated alumni network needs to be developed. Regarding the student surveys, the result provided in the faculty's self-assessment report is from 2018-2019 with a response rate of 37.5%. The lowest scores pertain to "possibility to gain international experience" and "master's thesis" and the highest scores pertain to "educational organisation" and "general satisfaction & learning environment".

Assessment of results
Assessment methods are well defined in the syllabus. Soft skills development and assessment might be improved through teaching peer assessment and the introduction of new elements of interaction into the courses.

Summary analysis - Advanced Master of Safety Engineering

Strengths:
- Programme that responds to a true demand from industry;
- Flexibility of the programme able to offer either a 1 year programme for students or a 2 to 3 year programme for working professionals;
- Close relationship between students and teaching staff;
- Significant number of guest lecturers (well aligned with the objectives of such an advanced master's).

Weaknesses:
- No substantial progress as regards the development of a dedicated alumni network and an adapted communication plan to attract higher quality students from abroad (these were 2 recommendations from the 2016 CTI evaluation report);
- Not enough master's theses proposed by industry;
- Workload distribution over the year not balanced enough; in particular the master's thesis starts too late.

Risks:
- Interruption of Essenscia financing.

Opportunities:
- Better attractiveness of European students thanks to a more adapted communication plan leading to a better visibility;
- Better promote the Prevention option which is not fully taught in Dutch (1/3 in Dutch and 2/3 in English) and which may attract a broader audience;
- Development of more one-week modules opened to industry;
- Development of teaching evaluation in order to better assess soft-skills;
- Alignment of programme outcomes with the skills matrix in 2023-2024 (when a revision of the programme is foreseen);
- Better capitalise on the multicultural environment of the programme to further develop an international culture.

Recruitment of engineering students

The faculty's strategy for admission to the master's programmes is to give the possibility for internal bachelor's students with a major or minor in a specific field to continue studies in the same area through direct admission and to admit holders of another master's degree.
According to the university's regulations, it is possible for students to enrol in a master's programme without a bachelor's degree, subject to certain requirements.
Some programme committees, for example in nuclear engineering, may impose additional or preliminary background courses, taking into account the curriculum content already completed by the applicants. Some master's programmes require a high level in two different fields, for example the Master of Energy requires knowledge in electrical and mechanical engineering. In this case, preparatory courses are in place to help students to catch up in the field where they are less skilled.
To attract international students, English language variants of some of the programmes have been created.

The recruitment methods of local students vary according to the applicants' background. Different recruitment methods are used in order to guarantee the learning outcomes and a good student success rate:

- There is an automatic enrolment for holders of a bachelor's degree in engineering from KU Leuven, provided they completed a major or minor in the relevant field (for example in mechanical engineering);
- Some other programmes (for example in mathematical engineering) do not require specific major-minor combinations;
- There is a lateral entry for holders of different bachelor's or master's programmes which requires a preparatory programme of at most 29 ECTS credits, tailored to the student's background.

International students go through a two-stage screening process: a web-based process, which is followed by a careful review of data, gathered by the admissions committee of each programme. There is no preparatory programme for international students. A detailed questionnaire is used to inform the students on the expected pre-requisites and to avoid misunderstanding about the programme's level and content. A GRE (Graduate Record Examinations) test was implemented in the 2021-2022 academic year, however no threshold value was set. Until now, the GRE test is recommended but not mandatory.
If the recruitment process is satisfactory, there are still some discrepancies between the success rates of foreign and Belgian students in some programmes. The compulsory GRE test may help provide better insight into the academic level of the foreign students.
The KUL "Chat with our students" communication medium could be used by the master's programmes for exchanges with future incoming international students.
Students from abroad must have a C1 English level and may have to take additional compulsory courses.
For the Advanced Master of Nuclear Engineering, clearance to access the control zone has to be delivered by the Federal Agency for Nuclear Control (FANC) and is a prerequisite to programme admission. For the Advanced Master of Nuclear Engineering, students are either full-time students who want an additional specialisation in nuclear engineering, or young professionals who are sent by their employer, or who are looking for employability in the nuclear industry.

In addition to the regular influx of Dutch-speaking students, the English-language variants of the programmes attract a steady inflow of international students. If the programmes wish to expand their international influx, more efforts should be placed on external visibility.

Analysis summary – Recruitment of engineering students

Strengths:

- Very strong motivation of the students who join the programme, especially for advanced master's programmes;
- English-language variants.

Weaknesses:

- In some programmes (mathematical engineering, mechanical engineering), the success rates of international students are lower than for holders of a bachelor's degree from KUL.

Risks:

- In nuclear engineering, a significant increase in the number of students could compromise the organisation of the programme;
- The implications of the Flemish language decree poses difficulties for a practical and efficient organisation of some programmes.

Opportunities:

- Merge Dutch-language and English-language variants into one programme taught in English (an increasing number of courses are already given in English).

Employment of engineering graduates

Programme coordinators and teaching staff are in close contact with industry and, therefore, well informed about the job situation and employment opportunities. Moreover, most of the programmes have well-established Industrial Advisory Boards which help them to keep in touch with practices, and to get feedback on the programme, and – more concretely – to provide topics for the case studies and project courses, as well as for the master's thesis.

Throughout the master's programme, students are in contact with diverse possibilities for future employment: via courses, projects and thesis work, students are in contact with industry allowing them to gather information for their future career. The VTK student union organises a job and internship fair each year, which provides a medium for employment in various sectors. At the university level, students have access to the KU Leuven Career Zone that offers extra teaching sessions on preparing for job interviews. The general interest courses (such as internships) allow students to orient themselves and prepare their career path.

Employment is excellent, as the need for engineers is high. Information that is more detailed is obtained from surveys, despite the low participation of the alumni. Most of the graduates had a job in less than 3 months after graduation.

There is a high diversity in post-graduation careers, ranging from academia to industry and entrepreneurship. However, the percentage of graduates starting a career in each field varies greatly from programme to programme. For example, approximatively 80% of the graduates from the Erasmus Mundus Master of nanoscience and nanotechnology pursue a PhD, whereas 10% of materials engineering graduates start their own companies. Alumni are highly positive about the programme's level and content, particularly regarding the combined breadth and depth of the programme, and the value of the scientific background they acquired.

There is an alumni association. However, alumni state that they actually have more contact with each other via other professional networks. The programmes could stimulate networking activities with a view to further improve the programme and to enhance community building. Short and medium-term alumni job and career analysis is not conducted.

Analysis summary - Employment of engineering graduates

Strengths:

- Employment of graduates: alumni are very positive and proud of the programmes and the tools given to tackle 'unknown' problems in industry;
- Good reputation in industry.

Weaknesses:

- N/A.

Risks:

- N/A.

Opportunities:

- Stimulate alumni networking activities to improve programme updating and community building.

Overall summary of the evaluation procedure

The Faculty of Engineering Science is clearly one of the leading institutions in Europe in the engineering field. All stakeholders met by the CTI expert panel are proud of the research and the education given and received at FES. Students do benefit from a great academic environment and impressive infrastructures. The faculty is attentive to developing long-term investment in very innovative and interdisciplinary programmes and to the quality of teaching. This translates in particular into international recognition.

However, some aspects could still be improved: gender balance among staff and students has not been achieved, surveys in general have low response rates, and are thus not really meaningful. Feedback to students on evaluation should be made systematic and maybe set within a reasonable time framework.

The binding legislation on the Dutch language of instruction, which implies a double workload for some courses, together with growing student numbers increases the workload of the teaching staff to extremely high levels.

Student workload is heavy, and attention should be paid to better organising exams and project reports so as not to overwhelm the students.

The faculty is seeking to develop partnerships with other Belgian universities to establish programmes taught in English, and is actively pursuing the development of MOOCs and active learning to provide world-class teaching in engineering with modern methods.

Overall analysis summary

Strengths:

- Great academic environment (campus facilities, campus itself, research environment);
- IT infrastructure (for education);
- Long-term investment in highly innovative and interdisciplinary programmes;
- An education that fosters creativity and problem solving capabilities;
- Self-reflection and flexibility of the programme directors;
- International recognition (in research and education);
- Mandatory training programme for faculty members;
- Enthusiasm of students who acknowledge the quality of education received;
- Most previous CTI recommendations addressed.

Weaknesses:

- Growing student numbers increasing the workload of the teaching staff to high levels;
- Low response rate of students to course evaluations;
- Low response rate of alumni to surveys;
- Feedback of exam results to students;
- Workload is not always in line with the amount of ECTS awarded;
- Success rate for foreign students is lower than for Belgian students;
- For some advanced master's programmes: ambitious and demanding programmes make it almost impossible to finish in the allotted time but could also be completed in two years, as an option.

Risks:

- Binding legislation on the language of instruction which implies a double workload for some courses;
- Help Dutch speaking students and staff to acquire a sufficient level of English to take / teach courses;
- External competition for the recruitment of students (national and international) for some programmes.

Opportunities:

- Association with the University of Louvain-la-Neuve to establish bachelor's programmes in English;
- Development of MOOCs and active learning;
- Strengthening the ties with alumni;
- Development of teaching evaluation.

- End of the evaluation report -