NVAO • THE NETHERLANDS

INITIAL ACCREDITATION

PROFESSIONAL MASTER ROBOTICS SYSTEMS ENGINEERING

Saxion University of Applied Sciences

FULL REPORT
10 May 2021

Content

1 Peer review

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

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

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

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

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

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

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

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

2 New programme

2.1 General data

Institution	: Saxion University of Applied Sciences
Programme	: Professional master Robotics Systems Engineering
Mode of study	: Full time
Degree	: Master of Science
Location	: Enschede
Study load	: 90 EC[1]
Field of study	: Technology (confirmed by panel)

2.2 Profile

With the MSc Robotics Systems Engineering, Saxion University of Applied Sciences (Saxion UAS) intends to train students in becoming systems engineers who are capable of developing the latest generation of robotic systems, including unmanned systems and smart industrial systems. Students acquire knowledge and skills to oversee the execution and evaluation of engineering projects for robotic systems, focusing on both technical content and business processes. As a professional master, the programme maintains valuable ties with TValley, a collaborative platform of several leading high-tech companies in robotics and mechatronics located in the hinterland of Saxion UAS. The new programme is offered by the School of Life Science, Engineering & Design and has been developed in close collaboration with the applied research group Mechatronics.

2.3 Panel

Peer experts

1. Prof. dr. Ming Cao (*chair*), professor in Networks and Robotics, Faculty of Science and Engineering, University of Groningen;
2. Dr. Felipe Nascimento Martins, lecturer and researcher, Institute of Engineering, Hanze University of Applied Sciences, Groningen;
3. Ton Peijnenburg MSc, research fellow, High Tech Systems Center (HTSC), Eindhoven University of Technology, and manager System Engineering, VDL Enabling Technologies Group, Eindhoven;
4. Willemijn Hoogland BEng (*student*), student MSc in Architecture, Delft University of Technology, and former student Honours Programme, Windesheim University of Applied Sciences, Zwolle, and Wentworth Institute of Technology, Boston (MA, USA).

Assisting staff

- Aurelie van 't Slot MA, secretary;
- Michèle Wera MA, NVAO policy advisor and process coordinator.

Site visit
Online, 6 April 2021

[1] European Credits

3 Outcome

The NVAO approved panel reaches a conditionally positive conclusion regarding the quality of professional master Robotics Systems Engineering offered by Saxion University of Applied Sciences. The programme complies with standards 1 and 2 of the limited NVAO framework and partially complies with standard 3.

Students of the MSc Robotics Systems Engineering receive high-quality training in the core professional tasks of systems engineers, focused on robotic systems. Graduates will have the knowledge, skills and understanding required to oversee the execution and evaluation of complex engineering processes for robotic systems, including both the technology and project management perspective. The profile of the programme is well-aligned with the needs and developments of the (regional) professional field. Strong involvement of the professional field is also apparent in the curriculum, where cases and assignments are often derived from professional practice. Nearly all courses are assessed with authentic professional products.

The study programme was developed in close collaboration with the Saxion research group Mechatronics. The curriculum is aligned with the Research & Development roadmap of the research group. Cases, examples and assignments are based on current applied research projects. In this way, state-of-the-art knowledge finds its way into the programme and students are taught the latest developments. The programme intends for students to meet and collaborate with researchers and (systems) engineers in a learning community. The close physical proximity to the research group Mechatronics will no doubt contribute to the establishment of this learning community.

The assessment policy of the School of Life Science, Engineering & Design, which guides the assessment of the MSc Robotics Systems Engineering, is well-thought-out. Many of the professional products that form the basis for examination are developed in a group setting. This method of assessment is particularly valuable for the proposed programme. It resembles professional practice where engineering projects are group efforts. However, it remained unclear how the programme currently guarantees assessment of the individual contribution to group work. Considering the broad range of backgrounds of incoming students, there is risk of students freeriding or social loafing.

In conclusion, the panel is convinced of the quality of the proposed programme and expects that the MSc Robotics Systems Engineering will be an attractive programme fulfilling a clear industry need. The individual assessment, however, needs to be clarified and safeguarded. All in all, the panel assesses the quality of the programme as conditionally positive.

The condition to be met within a period of two years is the following: the programme needs to ensure proper assessment procedures and tools are in place to safeguard the assessment of individual contribution to professional products developed in a group setting. This should also be apparent in both the assessments made and the accompanying individual assessment forms.

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

4 Commendations

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

1. Involvement of professional practice – The regional professional field is strongly involved in the programme. The profile of the programme is kept up to date by periodic discussion with the TValley board of industry. Cases and assignments in the programme are often based on professional practice, which befits its focus on industry application.

2. Collaboration with research group Mechatronics – The curriculum of the programme is aligned with the Research & Development roadmap of the Saxion research group Mechatronics. Cases, examples and assignments are derived from current applied research projects. In this way, state-of-the-art knowledge finds its way into the programme and students are taught the latest developments.

3. 'System Improvement' course – The inclusion of this course in system improvement is a smart and creative choice. Most engineering work is about the redesign and improvement of existing systems.

4. Community-driven approach – The programme intends to create a learning community where students meet and collaborate with researchers and (systems) engineers from the professional field. This community-driven approach allows students to broaden and deepen their knowledge, as well as work on their professional development.

5 Recommendations

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

1. Definition of systems engineer – Clearly communicate what the programme means by a 'systems engineer'. This is to the benefit of the expectations of both future students and future employers.

2. Theoretical foundations – Ensure sufficient coverage of the theoretical foundations of robotics systems engineering in the curriculum. A solid theoretical basis is a prerequisite for the development of professional products.

3. Intake and selection procedure – Carefully examine the criteria applied in the intake and selection procedure for students who are not directly admissible to the programme.

6 Assessment

6.1 Standard 1: Intended learning outcomes

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

Judgement
Meets the standard.

Findings, analysis and considerations
With the MSc Robotics System Engineering, Saxion University of Applied Sciences (Saxion UAS) aims to fulfil an industry need by educating students at master's level in systems engineering, focused on robotic systems. Industry professionals indicated that systems engineers with an understanding of robotics are a rare breed but are highly needed to manage the development of increasingly complex systems. Robotics systems engineers will have the knowledge, skills and understanding required to oversee the execution and evaluation of complex engineering processes for robotic systems, including the technology and project management perspective. As the programme management explained, the context of the multidisciplinary field of robotics brings a technical foundation to the study of systems engineering. The panel is of the opinion that the context of robotics befits the described 'robotization' of the regional manufacturing industry and the strategic ambitions of Saxion UAS in the area of Living Technology. It also recognizes the high demand for systems engineers who can operate on the interfaces between subsystems and various engineering domains.

Suitable intended learning outcomes have been formulated in line with this profile. Since there is no (inter)national definition of the exit level for a master's degree in the Engineering domain, the exit level of the MSc Robotics Systems Engineering has been operationalized in two core professional tasks, from which learning outcomes are derived. The panel established that the set of tasks and learning outcomes comply with the professional master standard and were validated by representatives of the professional field. The panel found that questions about the (engineering) domains covered in the intended learning outcomes were adequately answered during the online discussion with programme management.

The panel initially had trouble understanding whether the programme aims to train robotics engineers or systems engineers. The online discussions with programme management and the teaching staff made clear that the focus lies with systems engineers. Even so the delivered graduate differs from what is typically known as a systems engineer. In an industrial setting, systems engineers tend to be seniors with five to fifteen years of experience. In line with this observation, the panel questioned the feasibility of the starting positions included in the application file. The programme management clarified that starting positions depend on the size of the company. Becoming an independent robotics systems engineer still requires professional experience, but the operational setting of the programme supports students in accelerating their learning curve. Whilst the panel supports this view, it recommends the programme to clearly communicate its definition of a systems engineer to future students and future employers. This is to the benefit of their expectations. Additionally, the programme is advised to explain what is meant by 'investigative designer' as opposed to 'engineering researcher'.

Based on the application file, the panel got the impression that requirements from the (regional) professional field were strongly considered in the process of developing the programme. This impression was confirmed in the online discussion with representatives from the professional field, most of whom were involved since the inception of the programme. For example, the panel learned that skills associated with being an engineering professional were emphasized in the intended learning outcomes upon recommendation by industry professionals. The programme closely cooperates with TValley, a regional platform in which both SMEs and large high-tech companies in robotics and mechatronics are united. The profile of the programme is kept up to date by periodic discussions with the TValley board of industry. The programme also follows trends of the (inter)national community, such as the International Council on Systems Engineering. The panel found the profile of the programme to be clearly in line with industry expectations. It is impressed by the frequent and valuable interactions with industry.

Additional information shared prior to the site visit provided the panel with a clear overview of how the programme positions itself with respect to other (inter)national programmes addressing robotics systems engineering. In discussion with programme management, the panel found the benchmark also helped the programme to sharpen its own profile. It was pleased to hear that the programme management sought to align its efforts with developments at the University of Twente. Contrary to the research-enabled technology-driven focus of an academic master, the MSc Robotics Systems Engineering is focused on application in industry. This becomes evident from its close cooperation with the Saxion research group Mechatronics. The panel values the thought process that went into defining the professional orientation as complementary to an academic orientation.

In conclusion, the panel considers the profile of the programme to be relevant and well-aligned with the needs and developments of the (regional) professional field. Its explicit multi-domain orientation, focus on industry application and consideration of international trends pushes students to bring innovation to the professional field and accelerates their learning curve. Students receive training in the core professional tasks of the robotics systems engineer at master's level, which is expressed in a list of appropriate intended learning outcomes.

6.2 Standard 2: Teaching-learning environment

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

Judgement
Meets the standard.

Findings, analysis and considerations
The curriculum, including the graduation programme, is well-developed. Elements considered positively are the 'learning on the job' character of the programme and the strong involvement of the professional field (TValley) and research group Mechatronics. The curriculum distinguishes three types of courses: systems engineering courses, foundation courses and specialisation courses. Cases and assignments of the systems engineering courses are derived from professional practice, which is fitting considering the focus on industry application. In particular, the panel finds the inclusion of the 'System Improvement' course a smart and creative choice because most engineering work is about redesigning and

improving existing systems. During the site visit, the panel learned that the choice of specialisation courses was informed by the Research & Development roadmap of the research group Mechatronics and TValley. Cases, examples and assignments are derived from current applied research projects. The panel appreciates that, in this context, state-of-the-art knowledge finds its way into the programme and students are taught the latest developments. The foundation courses offer the knowledge and skills required for the specialisation courses and are meant to bring all students up to the same level. Since nearly all courses revolve around the development of professional products in a project setting, the panel does wonder if the theoretical foundations of robotics systems engineering are sufficiently covered. It recommends the programme to keep an eye on this.

Education in the master Robotics Systems Engineering adheres to the principles of the newly developed Saxion Education Model (Saxion Onderwijsmodel, SOM). This is reflected in the programme's focus on professional tasks, learning in communities and assessment for learning. The application file elaborates how the programme intends to create a learning community where students meet and collaborate with researchers and (systems) engineers from the professional field. In the context of the learning community, many (extracurricular) activities are offered to students. The panel appreciates these efforts, because they allow students to broaden and deepen their knowledge, as well as work on their professional development.

The School of Life Science, Engineering & Design (LED) intends for the programme to start as early as September 2021. During the online site visit, the panel has verified that appropriate measures are in place to deal with COVID-19 restrictions. Programme management explained that it has ample experience with a series of adjustments to the existing programmes in Mechatronics and Applied Nanotechnology. These adjustments can easily be applied to the proposed MSc Robotics Systems Engineering. The lab facilities moreover have sufficient capacity to allow the first cohort of students to learn and work at 1.5 meter distance. The panel remarked that the community-driven approach of the programme will be harder to implement in an online setting. Programme management recognized this concern. It intends to pay extra attention to incoming students, for example by creating an online MS Teams environment where students can meet. Saxion UAS furthermore developed an (online) buddy system in which senior students offer guidance to younger students. This system will be extended to the new master's programme.

The language of instruction is English. The programme management substantiates its choice by arguing that the engineering domain and associated industries have an international character. In professional practice products such as technical documentation delivered in the design cycle are in English. This facilitates communication with international clients, experts and other stakeholders. English is increasingly becoming more common as a main language on the work floor, which makes it essential that graduates have a professional proficiency in English. The panel supports this choice.

Admission procedures and criteria are clearly presented in the application file. Students can be directly admitted to the programme if they hold a bachelor's degree in applied computer science, applied physics, electrical engineering, mechanical engineering and/or mechatronics. Students holding a comparable bachelor's degree in the technical domain will be subject to an interview to, amongst others, check their knowledge of the subject and their motivation. In conversation with programme management and teaching staff, it became clear that a diverse

intake is preferred to enhance the students' learning experience. In a professional setting, the systems engineer is also expected to work with an engineering team that includes all disciplines relevant for the project. Whilst the panel supports the programme's wish for a diverse student group, it still has concerns about whether the intake procedure is strict enough. Simply expecting some students to work harder than others, as was mentioned during the site visit, does not seem to be a fail-safe and proactive approach. It therefore strongly advises the programme to have a closer look at the selection criteria, in particular for students who are not directly admissible.

The teaching staff consists of a mixture of lecturers primarily active in the research group Mechatronics and lecturers active in the bachelor's degree programmes offered by the School of Life Science, Engineering & Design. The panel values the strong representation of academically trained lecturers. Most lecturers have more than ten years of experience and have great expertise on computer science, software engineering, biomedical engineering, system and control, electrical engineering and data science. Because of the close collaboration between the MSc Robotics Systems Engineering and the research group Mechatronics, various researchers were involved in the design of courses and remain involved in the role of coach or expert. In addition, experienced systems engineers connected to the systems engineering competence group of TValley offer workshops on selected topics and provide students insights into the work of the systems engineer. The panel met a number of staff members during the site visit and found them well-qualified to implement and coordinate the programme.

Since the site visit was conducted online, the panel was unable to have a tour of the facilities. Instead, Saxion UAS provided the panel with a pre-recorded tour around the facilities of the research group Mechatronics and the proposed MSc Robotics Systems Engineering. These facilities include a lecture room, project spaces and a variety of lab environments, such as electrical and mechanical engineering workshops, OptiTrack and Vision laboratories, and an outdoor drone dome. In addition, students will have access to facilities outside of Saxion UAS, such as those of TValley. The panel is positive that the proper facilities are in place for students to carry out the educational activities. The close proximity to the researchers of the research group Mechatronics will no doubt contribute to the establishment of the envisaged learning community.

In summary, the panel recognizes a number of strong points in the proposed master programme: the community-driven approach of the programme, the quality of the teaching staff, the applied research context of the research group Mechatronics, and close collaboration with professional practice. Considering the relatively broad range of backgrounds of incoming students, the panel does wonder if the foundation courses offer sufficient theoretical foundations to have the desired homogenizing effect. In light of this concern, it advises the programme to re-examine the intake criteria and selection procedure. All in all, the panel is convinced that the programme offers a strong teaching-learning environment.

6.3 Standard 3: Student assessment

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

Judgement
Partially meets the standard.

Findings, analysis and considerations

The system of assessment of the master programme in Robotics Systems Engineering is guided by the assessment policy of the School Life Science, Engineering & Design (LED), which the panel found well-thought-out. In line with School policy, the proposed master programme has an exam programme prescribing the form of decisive examination per course. In addition to the assessment policy LED, the design of the exam programme follows the principles of the newly developed Saxion Education Model examination philosophy. These principles include integrated examination and assessment for learning. To achieve integrated examination, both evaluation and decisive examination in the programme are based on professional products, assignments and (oral) assessments. Assessment for learning is applied by including evaluation in various forms and feedback from multiple sources as an integral part of all courses.

In line with the SOM examination philosophy, the exam programme of the MSc Robotics Systems Engineering consists almost exclusively of professional products. Only the course *robotics foundation* has a more 'traditional' character with a focus on theory and mathematical skills and therefore does not result in a professional product. In many of the other courses, the professional products are developed in a group setting. The panel sees the value of this assessment method for the proposed programme, because it resembles professional practice where engineering projects are group efforts. That being said, it remained unclear to the panel how the programme guarantees individualized assessment within group work. This is an explicit requirement according to the Dutch Higher Education and Research Act (WHW)[2], Article 7.10, first paragraph. Also, the Teaching and Examination Regulations (OER)[3] should stipulate and guarantee the individual assessment of students.

During the online discussions, representatives of the programme placed emphasis on the use of lecturers as coaches who, through their professional dialogues with students, would be able to make individual assessments. Concrete criteria for evaluation activities during courses were not shared. For example, the panel did not receive rubrics that would allow assessment of complex aspects, such as individual attitudes in a group process, efficiently and reliably. This is especially relevant for the systems engineering courses, in which individual performance is included in the decisive examination. The programme management recognized the risk of students freeriding or social loafing, especially given the broad range of backgrounds. It also stressed teaching staff would maintain continuous vigilance.

In addition to the exam programme, there is a graduation programme which consists of two exams. These correspond to the core professional tasks that define the exit level. Students carry out these tasks in a context that provides an authentic learning environment. The programme has defined a clear set of quality criteria for said environment. The panel was also positive about the inclusion of a systems engineering coach and professional field representative in the assessment committee. The panel wondered whether the research group Mechatronics could guarantee a sufficient number of research projects for graduation but was reassured by the teaching staff that the research group currently runs approximately 30 projects. Taking into account the expected intake of approximately 30 students, this number is adequate. The examination of the graduation programme is based on the performance of each student individually.

[2] In Dutch: wet op het hoger onderwijs en wetenschappelijk onderzoek (WHW)
[3] In Dutch: onderwijs- en examenregeling (OER)

The master programme in Robotics Systems Engineering will fall under the responsibility of the LED graduation board[4] and forms a master's chamber within the graduation board with the programme Applied Nanotechnology. The panel established that the graduation board has the necessary level of independence and fulfils its tasks in line with its statutory duties. During the peer review, however, the representatives of the graduation board were only able to provide information at a general level. It seemed that the level of involvement in setting-up the proposed programme had been rather superficial. Whilst the graduation board reviewed the exam and graduation programme of the master, it has not yet seen any examples of assignment instructions and corresponding assessment instruments. It also made clear that its members do not have a lot of experience with group work as the basis for decisive examination. This raised the panel's concerns about safeguarding individual assessment at course level.

The panel concludes that the School of Life Science, Engineering & Design has a well-structured assessment policy, but it has seen insufficient evidence of how individual contribution in the project settings of the MSc Robotics Systems Engineering will be assessed. The panel expects that, if the individual assessment is clarified and safeguarded, the MSc Robotics Systems Engineering will be an attractive and innovative programme. Overall, the panel judges this standard as partially met.

6.4 Degree and field of study

The panel advises awarding the following degree to the new programme: Master of Science.
The panel supports the programme's preference for the following field of study: Technology.

[4] The LED graduation board has the same responsibilities as what is commonly known as the Board of Examiners.

Abbreviations

LED	Life Science, Engineering & Design
MSc	Master of Science
NVAO	Accreditation Organisation of the Netherlands and Flanders
Saxion UAS	Saxion University of Applied Sciences
SMEs	Small and medium-sized enterprises
SOM	Saxion Education Model

The full report was written at the request of NVAO and is the outcome of the peer review of the new programme Professional master Robotics Systems Engineering of Saxion University of Applied Sciences

Application no: AV-1021

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