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DEVELOPMENT OF A NEW MASTER´S DEGREE PROGRAM BASED ON WORK LIFE REQUIREMENTS

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Abstract:
Lapland University of Applied Sciences (Lapland UAS) started developing a new master´s degree program titled "Master of Renewing Industry" on topics related specially to twin transition and modern manufacturing technologies in spring 2021. Planning of the curriculum was based on the requirements of companies in the Northern Finland area as the contents and learning outcomes were derived from the demands of work life. The topics were constructed around modern manufacturing technologies used in the workplace taking digitalization, sustainability, and carbon neutrality into account. One major component in the curriculum is the master´s thesis where students select a development task from their work based on the themes of the degree program. Besides the professional element, the support of writing skills and written communication is continuous in the thesis process and plays an important role in student´s professional development as it increases their research abilities. As an example, from the study contents, a course titled "Industrial Production and Operations" is presented, which started in the beginning of the program in early 2022. Every study course has a designated teacher who plans, organizes, and is responsible for the successful delivery of the course, including the use of visiting lecturers and experts. Some of these visiting lectures are given by experts in the industry as the key point of all the courses is to strengthen work life orientation. This master's degree program supports lifelong learning of technical personnel in the workplace and enhances their potential to adopt the best principles of sustainability and twin transition.

Keywords: Master´s degree, curriculum, twin transition, communication, work-life

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1. Introduction

Modern work life and labor markets are facing new kinds of challenges as the rapid pace of technological evolution sets new demands on skilled workforce everywhere. This includes the adoption of new manufacturing technologies, the ability to adapt to new circumstances, and the implementation of twin transition approaches in company operations. In addition, companies nowadays have to adjust their operations (based on legislative demands) to include sustainability themes to meet these requirements. Therefore, the education of the technical workforce must necessarily include these themes. Through higher education at the master's level, these students can transfer the knowledge acquired and thus support the companies in the implementation of sustainability and green transition requirements together with advanced technological solutions.

The aim of this paper is to present an example of the creation of a new master's degree program at Lapland UAS, based on the educational needs of future engineers and the needs coming from the labor market and the current needs of companies. This includes the themes of digitalization, twin transition, and sustainability.

2. Creating a new Master´s degree program

Lapland UAS started developing a new master´s degree program titled "Master of Renewing Industry" on topics related especially to digitalization, twin transition, and modern manufacturing technologies in spring 2021. The scope of the degree is 60 ECTS, and it is implemented over one academic year (two semesters). The structure of the program is as follows:

- Core competence studies (compulsory): 25 ECTS;
- Profiling competence studies (free elective): 5 ECTS;
- Master´s thesis: 30 ECTS.

The rapid pace technological development, especially related to adopting digitalization themes in manufacturing technologies by companies in Northern Finland, created the need for updating the knowhow of engineers who are involved in such work. The degree is meant for engineers working in different areas of technology such as mechanical, electrical, automation, and information technology.

The educational framework consists of three different elements and is presented in Figure 1.

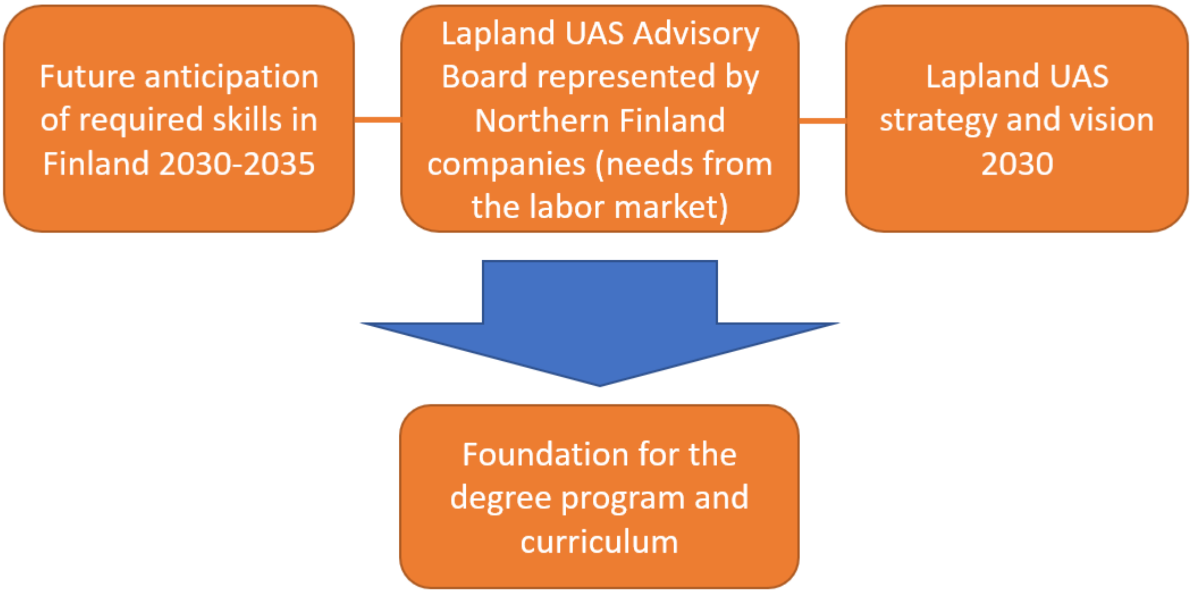

Figure 1: Framework for the new master´s degree program

As shown in Figure 1, the first element consists of the projected skills requirement in Finland for the period 2030–2035, which were based on research conducted by Technology Industries Finland (Technology Industries Finland, 2022) and Finnish National Agency for Education (Finnish National Agency for Education, 2022a, 2022b). The main aim of this research was to map out the required skills needed in different sectors of society and technology for the future, and represent the required knowhow in Finland related to technological development to maintain and develop the technological competitiveness of Finnish companies. The second element consists of inputs provided by Northern Finland companies (metal, paper, pulp, manufacturing, etc.) as represented in the Lapland UAS Advisory Board, presenting the needs of the labor market. The board participates in mutual discussions with Lapland UAS on a regular basis aiming to develop company cooperation in different areas, one of them being to customize the courses at the master's level of engineering to meet the specific needs of companies. The board participated in evaluating and commenting on the contents of the new master's degree program. At this stage, a three-phased detailed questionnaire targeted at representatives of Northern Finland companies giving a broad view of the required contents of the degree was administered. The third element of the program was derived from the Lapland UAS strategy and vision for 2030, which ensures the quality of the provided education in Northern Finland. Based on these three elements, the main topics and foundation for the curriculum were prepared as follows (presenting the needs of the labor market in terms of educational topics):

- Understanding and developing modern production technologies;
- Modern automation solutions and adopting technological applications in companies (e.g., IoT, digital twin, and robotics);
- Modeling and simulation of industrial processes;
- Twin transition in company functions (digitalization, sustainability, carbon neutrality, environmental expertise, energy efficiency, etc.);

- Digital product development expertise;
- Identification of technological development possibilities;
- Management and leadership skills; and
- Operational and strategic development in companies.

These topics form the core from which the necessary professional competences, learning outcomes, and courses for the curriculum were created. The first step in creating the curriculum was to form specific competence groups based on the derived themes. Competence areas included the description of learning outcomes and the required knowledge a student gains after the successful completion of a certain course (Kangastie, Mastosaari, 2016). Table 1 presents the main competence groups and some examples of the learning outcomes.

Table 1: Professional competence groups and learning outcome examples for curriculum development

Competence group	Learning outcome examples (the student ...)
INDUSTRIAL EXPERTISE	- can compare modern production technologies and develop them according to company goals - can apply new technologies in practice and develop efficiency in production - can analyze and compare data from processes with different methods - can compare operative and stratetical development targets and create information for decision making - can lead operative and strategic development projects
DIGITALIZATION EXPERTISE	- can interpret the essential digitalization factors and apply them in practice - can connect digital solutions to company operations and develop them - can compare digital tools and platforms and use them in developing functions and intelligent process control
AUTOMATION TECHNOLOGY EXPERTISE	- can evaluate modern concepts of automation and use them to create new solutions which improve company operations and functions in production - is able to evaluate technological solutions linked to automation and use them in creating new and improved technologies and solutions
ENERGY AND ENVIRONMENTAL EXPERTISE	- can analyze the energy efficiency of products and systems and develop operations based on this - is able to evaluate the meaning of twin transition and carbon neutrality for company and develop and lead projects based on this - is able to describe and evaluate development needs based on sustainability and environmental responsibility

In addition to the professional competencies, The Rectors' Conference of Finnish Universities of Applied Sciences (Arene, 2022) has made recommendations for shared competences to be included at the bachelor's and master's levels. These general competences provide a platform for enhancing student skills in various general areas of education. Similar to professional competences and their learning outcomes, shared competences include learning outcomes that can be included in courses. The connection of both competence types to the courses was done via a competence matrix that enables the planning of course contents. Table 2 presents the competence matrix with created courses.

As shown in Table 2, competence matrix allows the implementation and planning of the course contents. As the competence groups have been connected to courses, suitable learning outcomes from each competence group can be picked to each course. These learning outcomes form the description of the acquired knowhow when the student successfully passes the course. The level of acquired knowledge is based on the course evaluation scale (Level 1–5, where 1 = Satisfactory and 5 = Very good). The course evaluation assessment criteria are derived from the learning outcomes as they describe the achievable level for each grade. As a result, implementation plans for the degree courses were created and constructed based on to the competence matrix.

Table 2: Competence matrix

		GENERAL COMPETENCES						PROFESSIONAL COMPETENCES			
		1. Learning to learn	2. Operating in a workplace	3. Ethics	4. Sustainable development	5. Internationality and multiculturalism	6. Proactive development	1. Industrial expertise	2.Digitalizaion expertise	3. Automation technology expertise	4. Energy and environmental expertise
Semester 1 (30 ECTS)											
5 ECTS	Industrial Production and Operations (mandatory)	X			X	X		X			X
5 ECTS	Management and Safety Control (mandatory)	X	X				X	X	X		
5 ECTS	Development Methodologies of Working Life (mandatory)	X	X	X	X	X	X				
10+10 ECTS	Master´s Thesis (planning and implementation phase)	X	X	X	X	X	X	DEPENDENT ON TOPIC			
Semester 2 (30 ECTS)											
5 ECTS	Autonomous Operating Environment (mandatory)			X			X			X	X
5 ECTS	Process Modeling and Simulation (mandatory)	X					X	X	X		
5 ECTS	Digital Product Development and Modern Manufacturing Methods (elective alternative)			X				X	X		X
5 ECTS	Robotics and Automatic Systems (elective alternative)				X	X			X	X	X
10 ECTS	Master´s Thesis (finishing phase)	X	X	X	X	X	X	DEPENDENT ON TOPIC			

3. Supporting communication skills in the Thesis process

The scope of the UAS master's thesis is 30 credits (810 working hours) and corresponds to the European Qualifications Framework (EQF) Level 7. It is divided into three phases: planning, implementation, and finishing (Lapland UAS, 2023). Every thesis has its own supervisor who guides the process and substance. During the process, there is also a Finnish language teacher supervising the language and reporting. Every student has a different self-planned schedule, but there are also thesis workshops held every month for the whole group providing support in different areas such as research methods, reference notations, or academic writing. As a result of the assistance provided in these workshops, students are able to keep up with their schedule and graduate in time. Experience has shown that students require considerable personal support, especially in the beginning of the thesis process. Some students might have spent a longer time since their previous studies, and therefore the challenges of starting master's studies, academic writing, and working on a thesis might be harder for them.

Students usually start planning their theses immediately after beginning their master's studies; some may also have a topic in their mind even before the beginning of the studies. A typical topic is an analysis and development research task from the student's own workplace/company. Students may have rich work experience, but they have not been involved in academic writing for a long time. For this reason, it is important to also have language and writing support during the studies. Students can also choose a volunteer course titled "Writing as a Specialist," which offers extra support for academic writing.

4. Building work life skills

The following presents an example course that aims to build the work life skills of students. This course called "Industrial Production and Operations" is offered in the first semester of the program. It is a mandatory course, and the aim of the course is to give students an extensive idea of how to improve the operations of a company in different contexts. The content of this course includes various fields of knowledge such as operations management, new production technologies and strategic development of production, additive manufacturing, the role of automatization, artificial intelligence, and machine learning. The components of sustainability, responsibility, and green transition to production technologies are included in the contents of the course. Students receive some basic knowledge in each of these themes; however, they are provided with the opportunity to deepen their competence in any of these areas during the degree program.

All the courses always include a designated teacher who plans how to implement the content of the course. The teacher plans the pedagogical content of the course, how the lectures are conducted (e.g., face-to-face, online, etc.), and how to evaluate student competence based on specified criteria. The content of the example course is vast, and the teacher responsible has the option of using experts and guest lecturers. These expert lectures are given by industry representatives and other organizations or Lapland UAS teaching staff/experts.

Students receive new knowledge and examples of how different course themes are implemented in industry and organizations. The course strengthens work life orientation, and students can transmit the knowledge to their own organizations. The aim of the course is to promote lifelong learning and the continuous development of work life. Students write a portfolio of the themes and the lectures given during the course. The role of the lectures is to act as a stimulus to the information retrieval and students deepen their competence of the processed themes by reflecting examined subjects to the portfolio. Communication and exchange of views are also important in the learning process, and students participate in such activities during lectures and online via Moodle. Students start their thesis process at the beginning of their studies; they can also emphasize information retrieval to apply to their thesis subject. Portfolio writing also promotes the writing process of the thesis.

5. Summary and future outlook

Such 1-year M.Sc. degree programs based on work life needs function very well as fast-track education. As the degree program consists of 30 ECTS of targeted professional substance courses and 30 ECTS master's thesis, it offers the possibility for companies to update the knowhow of their employees. The high speed of technological changes challenges companies in new ways, and this requires skilled and trained workforce.

During the writing of this article, this new master's degree program is on its halfway mark. The initial feedback from the students has been very positive. One key issue has been the thesis process, which is supported and phased in a way to give the students a better substrate to start their independent research work in order to solve the actual problems in their work life. The students need constant personal contact with their supervisor, which gives them ideas and motivation and thus improves their ability to perform better in studies. The goal is to collect full feedback at the end of 2023 when the program ends and make improvements and changes to the curriculum for the next batch of students. This will include collecting feedback from the students as they take the acquired knowledge to their companies. This type of feedback will hopefully provide a direct view regarding how the contents of the degree program have been successful in real-life operations and what still needs to be changed. Modern methods of educating engineers require flexible curricula that can be adjusted based on feedback in every implementation cycle, and this requires active and continuous conversations with the labor market.

Conflict of Interest Statement
The authors declare no conflicts of interest.

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Ari Pikkarainen, D.Sc. (tech.) is working as a Principal lecturer in Lapland University of Applied Sciences (Lapland UAS) Mechanical engineering degree program and Master School in Kemi, Finland. Pikkarainen is a teacher of technical subjects such as additive manufacturing, product development, mechanical calculations and energy technology. He has been working also as a mechanical designer in different areas such as steel- and paper industry. Pikkarainen acts as a main responsible person of "Master of Renewing Industry" Master´s degree program. He was the main responsible person in planning and constructing the degree program. Pikkarainen has acted as a main responsible member of curriculum development team in the Lapland UAS mechanical engineering degree in 2008-2012. In addition, he acted as the main responsible teacher (guiding a team of teachers and R&D personnel) in renewing the Lapland UAS mechanical engineering curriculum in 2014-2017.

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