FINNISH EDUCATION
EVALUATION CENTRE

REVIEW OF THE DEGREE PROGRAMME IN MECHANICAL ENGINEERING AT JAMK UNIVERSITY OF APPLIED SCIENCES

David Tanner
Antti Huuskonen
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1 Description of the review process and of the programme

1.1 Aim of the review

The aim of FINEEC's Engineering Programme Reviews is to support enhancement of quality in engineering programmes and to provide higher education institutions with the means to decide if an engineering study programme provides its graduates with the academic qualifications necessary for a career in the engineering profession.

The review assesses the way an engineering degree programme is planned, delivered and developed to ensure that the students reach the programme outcomes; and how the programme outcomes align with the reference programme outcomes set in the FINEEC Engineering Programme Review manual. The reference programme outcomes describe the knowledge, skills and competencies that engineering students should have acquired by the time they have completed a degree programme in engineering.

The review evaluates the extent to which the set standards for programme's organisation, implementation and development are met.

1.2 Degree programme in Mechanical Engineering

The engineering programme under review was the Degree Programme in Mechanical Engineering (DPME) at JAMK University of Applied Sciences (JAMK), located in the city of Jyväskylä in central Finland.

The degree awarded from the programme is a Bachelor of Engineering delivering a total of 240 ECTS credits over 4 years of full-time study, including a 30 ECTS practical training. Students have an opportunity to take a double degree according to an agreement with Esslingen University of Applied Sciences (Germany).

The intake to the programme in 2015 will be 56 students. The programme is run in Finnish although some courses are provided in English during the studies.

The programme has two areas of specialism: product development and production engineering. The majority of studies during the first two years are common to both specialisms.

According to the self-evaluation report the programme prepares the students to apply engineering knowledge such as problem solving and critical thinking in working life; students learn to carry out different types of development and design tasks in the field of mechanical engineering (students specialised in product development) or perform tasks as developers and experts in the field of workshop manufacturing (students specialised in production).

1.3 The review process

The review was conducted in accordance with the principles set in the review manual. The schedule of the review process was the following:

- JAMK University of Applied Sciences submitted the self-evaluation report on 13 February 2015.
- The review team was appointed by the FINEEC Committee for Engineering Education on 2 March 2015.
- A review visit to the programme was conducted on 24–25 March 2015. The programme of the visit is illustrated in figure 1.
- Decision making meeting of FINEEC Committee for Engineering Education on 28 May 2015.

	1st day		2nd day
9.00 — 10.00	Interview of the management of the HEI and of the programme	9.00 — 9.40	Interview of external stakeholders
10.10 — 11.20	Interview of academic staff of the programme	9.50 — 10.40	Interview of alumni
11.30 — 12.20	Interview of support staff members	10.50 — 11.50	Interview of students
13.30 — 14.45	Evaluation visit to the relevant facilities	13.00 — 14.50	Study of evidence provided by the programme
14.45 — 15.00	Short presentation of the evidence room		
15.00 — 15.50	Study of evidence provided by the programme	16.00 — 16.30	Preliminary feedback to the management

Figure 1: Schedule of the review visit

1.4 The review team

Chair of the review team:

David Tanner, Lecturer in Manufacturing Process Technology, University of Limerick, Ireland

Members of the review team:

Antti Huuskonen, Business Consultant at Talentree

Robert Kristof, MSc student at Universitatea Politehnica Timisoara, Romania

Lotta Saarikoski, Head of the Mechanical Engineering Department, VAMK University of Applied Sciences, Finland

FINEEC project manager:

Touko Apajalahti, Senior Advisor.

1.5 Evidence used in the review

The results of the review and the analysis in the review report are based on the following evidence:

- Self-evaluation report of the programme, including the following appendices
    1. Degree Regulations of JAMK University of Applied Sciences
    2. Ethical principles for JAMK University of Applied Sciences
    3. Programme outcome level analysis: General description of the Curriculum
    4. Programme course level analysis: Matrix of Learning Outcomes and Competences
    5. Definitions of used Competencies
    6. Summary of the number of applicants and attraction 2011-2014
    7. Basis for the 2015-2016 Curricula
    8. Study structure and individual courses of the programme in Mechanical Engineering
    9. Diagram of the study structure with courses
    10. National mechanical engineering professional skills
    11. Compiling a curriculum (process description)
    12. Staff description
    13. Path for student guidance 2013
    14. OPALA 2013, Inquiry for the graduates in 2013
    15. One year after graduating placement follow-up survey
    16. Five years after graduation career follow-up survey
    17. Course feedback (mid-term feedback) form

18. Example 1 of course feedback analysis
19. Example 2 of course feedback analysis
20. The Cross-Evaluation of the Degree Programme in Mechanical and Production Engineering (2008), Evaluation Summary
21. Composition of the Advisory Board: Degree Programme in Mechanical and Production Engineering
22. JAMK Quality Manual
23. Quality Guide, School of Technology
24. JAMK Technology´s HEI Agreements
25. Statistics of Student and Staff Exchange
26. RDI Projects
27. Publications
28. Development of key indicators
29. Industry cooperation
30. Placement research published by Insinööriliitto IL

- JAMK online study guide and the material in JAMK online portal Optima;
- Evidence gathered by the programme to the evidence room, which included course material, thesis works, project works among other things;
- Tour of the relevant facilities: Mechanical engineering laboratory (production automation, material testing, prototype workshop), computer lab and classrooms, automation technology laboratory and the JAMK main library; and
- Interviews with management, teaching staff, support staff, students, alumni and external stakeholders

2 Evaluation of the programme's organisation, implementation and development

2.1 Needs, objectives and outcomes

Standard 1: Needs of the interested parties (students, industry, trade unions, etc.) should be identified.

The review team evaluates the fulfilment of the standard to be ***acceptable***.

JAMK Mechanical Engineering programme has an Advisory Board which consists of representatives of the companies and corporations from manufacturing industries, engineering offices and the City's regional development company, the Head of Industrial Engineering Department, the Head of Mechanical Engineering Programme and two student representatives. The Advisory Board meets twice a year and discusses the main issues and requirements of all of the involved parts. Memoranda are written from the meetings which the review team had the opportunity to study during the site-visit.

The companies in the Advisory Board are the most important in the region, mainly production and product development companies, but also design companies. There are no strict rules regarding the mandate in the board, usually the members stay for 5-6 years. Also, the needs of industry from abroad are identified through the work projects with large companies from outside of Finland.

Another way for the programme to stay current with the industry's needs are the RDI services that the department provides for companies, both regionally and globally. Teachers typically take part in these projects, depending on their expertise and on the subject of the project. By working with the companies, the teachers can observe real needs and challenges of industry, and can use this practical information when developing the programme.

According to the interviews, staff members also use surveys completed by the engineering and employers' associations regarding the needs of engineers in the labour market.

The needs of students are identified, primarily through the Advisory Board which includes two student representatives that can present the students' points of views and issues in the board meetings. According to the staff, the student representatives of the advisory board are now more involved in the meetings than previously. This fact was also highlighted by the industry representatives. Secondly, the students contribute in the development and implementation of the curricula by providing course feedback, surveys, and feedback during the meetings with their tutors. Mid-term feedback is also implemented and based on this feedback, teachers change their teaching methods or learning resources. In addition, tutor teachers have frequent meetings with students, creating another channel for information concerning student needs.

The review team's conclusion is that the needs of the interested parties have been well identified within the programme.

Standard 2: Educational objectives of the programme, which describe the educational task and purpose of the programme, should be consistent with the mission of the higher education institution and with the needs of the interested parties.

The review team evaluates the fulfilment of the standard to be ***acceptable***.

The aim of the Degree Programme in Mechanical Engineering is to educate engineers who meet the needs of the business life and who are competent in renewing the competitiveness of the industrial organisations.

The mission of JAMK is to provide higher education that prepares students for professional specialist tasks and positions, based on the demands and development of working life, and on research, artistic and cultural considerations. Further aims include supporting the students' individual professional growth and conducting applied R&D that support and serve higher education and regional development, with consideration of the region's economic structure.

It is very clear that the programme's educational objectives are consistent with the mission of the higher education institution and with the needs of interested parties.

Standard 3: Programme outcomes should cover the programme outcomes for review

The review team evaluates the fulfilment of the standard to be ***acceptable***.

The programme defines its programme-level outcomes as the *targeted competence* upon completion of the programme. The definition is published and is a part of the JAMK study guide, available on the JAMK website. The definition of the targeted competence in the study guide makes implicit references to the EUR-ACE criteria and could be used as evidence regarding the way that programme outcomes cover the reference programme outcomes used in the FINEEC Engineering Programme Reviews.

The competence targets are prepared by a work group consisting of teachers of the degree programmes. The members of the group negotiate with representatives of trade and industry in their respective fields on competence needs in the labour market. The group then compiles the competence targets and defines them for the degree programme.

The competence targets are divided into competence areas and subordinate qualifications, and incorporated into the degree programme structure in the form of various courses. The targets are reviewed by a committee consisting of representatives of trade and industry, student members, the Head of Department and the Programme Coordinator.

Based on an analysis of the targeted competence of the programme, as defined in the study guide, the programme's outcomes clearly cover the *FINEEC reference programme outcomes,* as discussed in more detail in the following sections.

Knowledge and understanding

- *Knowledge and understanding of the scientific and mathematical principles that are central to their branch of engineering;*
- *A systematic understanding of the key aspects and concepts of their branch of engineering;*
- *Coherent knowledge of their branch of engineering, including also knowledge in the forefront of the branch;*
- *Awareness of the wider multidisciplinary context of engineering.*

According to the *targeted competence*, the students "possess basic expertise in natural sciences, which enables the mastery and further development of the basic skills of mechanical engineering. These include the basic skills of mechanical engineering, machine design and production technology."

The awareness of the wider multidisciplinary context of engineering is addressed with the outcome "The students understand the realities of the global mechanical engineering industry/ production and can view the engineering workshop production as a whole."

Engineering analysis

- *The ability to apply their knowledge and understanding to identify, formulate and solve engineering problems using established methods;*
- *The ability to apply their knowledge and understanding to analyse engineering products, processes and methods;*
- *The ability to select and apply relevant analytic and modelling methods.*

The *targeted competence* of the programme defines rather clearly how the students are able to apply the knowledge and understanding in solving engineering problems and in analysing various engineering products, processes and methods. For example, according to the *targeted competence* the students are "capable of performing technical calculations and understanding technical documentation" and "are capable of utilising modern software and taking into account technical factors relating to strength, material and manufacturing".

Also the ability to select and apply relevant analytic and modelling methods is taken into account in the definition, with examples like "are capable of performing strength calculations and can model machine components and create workshop drawings based on them" or "The students know the basics of actuator technology and can select the appropriate equipment".

Engineering design

- *The ability to apply their knowledge and understanding to develop and realise designs to meet defined and specified requirements;*
- *An understanding of design methodologies and an ability to use them.*

According to the *targeted competence*, the students specialising in production engineering are "able to develop manufacturing of products", "are familiar with the various production systems and can take them into account in their choices", "can develop processes utilising a variety of development techniques"

Correspondingly, the students with specialisation in product development "can develop and design machines and equipment" and "are capable of utilising modern software and taking into account technical factors relating to strength, material and manufacturing".

Investigations

- *The ability to conduct literature searches and use databases and other sources of information;*
- *The ability to design and conduct appropriate experiments, interpret the data and draw conclusions;*
- *Workshop and laboratory skills*

The *targeted competence* includes outcomes related to how students are able to use different kinds of information sources and describe the kind of workshop and laboratory skills are attained in the programme.

For example, the *targeted competence* states that students "have good capabilities for information retrieval"; are capable of "understanding technical documentation and both domestic and foreign publications in the technical field, and applying them in their own work"; and "have mastered the production technologies of engineering workshop production".

Nonetheless, the outcomes related to how the students are able to design and conduct experiments and use the data to draw conclusions could be defined in a more specific way in the *targeted competence* in the study guide; especially as these skills are included in the curriculum.

Engineering practice

- *The ability to select and use appropriate equipment, tools and methods;*
- *The ability to combine theory and practice to solve engineering problems;*
- *An understanding of applicable techniques and methods and of their limitations;*
- *An awareness of the non-technical implications of engineering practice.*

How the engineering analysis, engineering design and investigations skills and competences build into engineering practice outcomes is well reflected in the *targeted competence* and integrates the awareness of the non-technical implications of engineering.

For example, the *targeted competence* states that after completing the programme, students "understand the operating principles and selection criteria of the most important machine components" and can "develop and design machines and equipment", "expand their competence to include user-centred design", "model machine components and create workshop drawings based on them, "develop processes utilising a variety of development techniques" and "make justified choices and develop production".

Transferable skills

- Function effectively as individuals and as members of a team;
- Use diverse methods to communicate effectively with the engineering community and with society at large;
- Demonstrate an awareness of the health, safety and legal issues and responsibilities of engineering practice, understand the impact of engineering solutions in a societal and environmental context, and commit themselves to the professional ethics, responsibilities and norms of engineering practice;
- Demonstrate an awareness of project management and business practices, such as risk and change management, and understand their limitations;
- Recognise the need for and have the ability to engage in independent, life-long learning.

Outcomes related to transferable skills are mainly defined through communication skills, professional development skills and entrepreneurship competences. For example, according to the *targeted competence*, the students "have good capabilities for continuous professional development and diverse communications in different work and cultural environments", "have adopted an entrepreneurial and innovative approach, and are capable of working as an entrepreneur", "have a strong ethical foundation in their field" and "possess the knowledge and skills required for management".

Also health and safety issues are mentioned, such as "the students are familiar with the basics of safety in electrical work" but could be made more explicit.

Standard 4: Programme outcomes should be consistent with the programme's educational objectives.

The review team evaluates the fulfilment of the standard to be acceptable.

According to the self-evaluation report, the programme's educational objectives are to "educate engineers who meet the needs of the business life and are competent in renewing competitiveness of the industrial organisations. The Degree Programme in Mechanical Engineering provides the skills for practical application of mechanical engineering in product development and workshop production. The aim and educational objectives of the programme are based on the needs of the interested parties and the mission of JAMK."

The *targeted competence* of the programme, discussed in detail in the previous chapter, builds upon, and is consistent with, these overall educational objectives.

After discussions with the external stakeholders, the review team acknowledges that the programme outcomes also ensure the targeted engineering skills, and therefore fulfil the programme educational objective of meeting the needs of the business life.

Strengths, good practice and areas for further development regarding the Section 2.1: Needs, objectives and outcomes

The team notes the following **key strengths** in this section:

- The needs of the local industry and students are gathered systematically and there is a well-established system in place in JAMK to collect this information and act upon it. The students´ evaluations are gathered and addressed in an efficient manner.
- The programme fulfils well the needs of the local industry and has close connections to working life and it is frequently revised taking into account the current needs of industry.

The team would like to highlight the following **good practice** in this section:

- International co-operation provides peer assessment and benchmarking possibilities so that the programme can be developed.
- The quality and quantity of teachers' participation in RDI projects with companies

The team sees the following as **areas for further development** in this section:

- The outcomes related to how the students are able to design and conduct experiments and use the data to draw conclusions could be defined in a more specific way in the *targeted competence*
- In the course descriptions of the study guide, the programme references both JAMK and EUR-ACE competences. More attention should be paid to this analysis; for example project courses are not at all assigned to the EUR-ACE competence on transferrable skills.

2.2 Educational process

Standard 5: The curriculum should ensure the achievement of the programme outcomes.

The review team evaluates the fulfilment of the standard to be ***acceptable***.

The curricular work is clearly defined and guided in JAMK and a separate document for this exists. In this document the starting point for curricular work is set, rules and ways of working for student guidance and assessment principles are defined, the education planning process and the responsible persons are described. Also, the required graduate attributes and the related learning outcomes and different courses` intended learning outcomes as well as the degree programme contents are set in this document. Finally, the last part of this document describes how degree programmes are implemented according to JAMK`s strategy.

All courses and the related competences are described comprehensively in the Study Guide on JAMK's website from where they are easily accessed by anyone. The Study Guide includes a table of the individual courses linked to the intended competences. From this table, it is easy to see each course's contribution to the programme's *targeted competence*. Also, the definition of each course in the study guide references the *targeted competence* that they contribute to.

The following sections discuss in detail how the curriculum ensures the achievement of the different programme outcomes.

Knowledge and understanding

- *Knowledge and understanding of the scientific and mathematical principles that are central to their branch of engineering;*
- *A systematic understanding of the key aspects and concepts of their branch of engineering;*
- *Coherent knowledge of their branch of engineering, including also knowledge in the forefront of the branch;*
- *Awareness of the wider multidisciplinary context of engineering.*

Based on the self-evaluation and the evidence reviewed during the site-visit, the programme provides students with the solid scientific and mathematical basis needed in studying mechanical engineering and also the key aspects and main concepts of mechanical engineering, creating an overall holistic view of this engineering field for graduates. There are a large number of subjects during the degree where students' knowledge is evident including for example, the first year physics and production engineering II subjects. A notable part of the mathematics and physics studies has been integrated to the professional studies, which can help students to better grasp the link between scientific principles and their branch of engineering.

The programme provides possibilities to study in contexts where the need for multidisciplinary approach will be recognised by the students, for example project work, often done on real-life topics from industry, and the so-called innovation week. The project work that is completed with industry also serves the purpose of introducing knowledge at the current forefront of mechanical engineering technology to students.

Overall, students and employers interviewed were very pleased with the level of knowledge and understanding obtained from the programme.

Engineering analysis

- *The ability to apply their knowledge and understanding to identify, formulate and solve engineering problems using established methods;*
- *The ability to apply their knowledge and understanding to analyse engineering products, processes and methods;*
- *The ability to select and apply relevant analytic and modelling methods.*

In order to pass the courses in the curriculum, the students must be able to apply the acquired knowledge to solve engineering problems using established methods and tools. The programme has two specialisation areas (Product Development and Production Engineering) and six secondary subjects which can be chosen by the student. Each specialisation consists of courses in which the students must conduct engineering analysis tasks in order to pass them.

Students are given the opportunity to learn various solid modelling packages and to learn finite element analysis. This gives the students a clear opportunity to apply their engineering analysis skills. The students also take on an in-depth project in their final year where they apply a range of engineering methodologies to solve industrially relevant problems. The laboratories that were shown during the tour of facilities also demonstrated how the students learn to use engineering analysis techniques to solve automation and materials related problems. From the evidence provided, there seems to be sufficient depth and breadth within the course to ensure that graduates have the ability undertake some in-depth engineering analysis.

Based on analysing several courses, such as Production Automation 2 or Strength of Materials, available in the evidence room and the contents of the courses in Optima online portal, the review team believes that the subjects of the projects are designed to fit real-life requirements and that they help the students to solve real engineering problems. As one example, the Strength of Materials course includes real life structural engineering problems which the students learn to solve.

The engineering analysing skills are essential also in the final year thesis work. Topics of the theses originate mainly from real-life industrial problems and are approved by the programme.

The team received positive feedback regarding the programme also during meetings with students and alumni. Alumni felt that they have not had problems applying what they learned during the degree in working life. The review team regards this as strong evidence of how the curriculum enhances the students' ability to apply their knowledge and understanding to analysing engineering products, processes and methods.

Engineering design

- *The ability to apply their knowledge and understanding to develop and realise designs to meet defined and specified requirements;*
- *An understanding of design methodologies and an ability to use them.*

There are a large number of subjects in the curriculum where students get to learn and practice engineering design. The students study mechanics and also complete a lot of solid modelling and have an opportunity to learn finite element analysis.

A good example of engineering design was given during the visit which related to the design of sheet metal structures. There is also an opportunity for students to complete engineering design projects during their final year project and to get involved in the RDI projects. The students also undertake a design project module in their fourth year. Some of the students felt that they would be better off learning one solid modelling package well, rather than spending time learning lots of different packages, but they all agreed that they were well prepared for design related problems in industry. A couple of graduate students interviewed had progressed to working as design engineers and felt well prepared for their new roles.

The curriculum clearly gives the students the opportunity to achieve this programme outcome.

Investigations

- *The ability to conduct literature searches and use databases and other sources of information;*
- *The ability to design and conduct appropriate experiments, interpret the data and draw conclusions;*
- *Workshop and laboratory skills*

Based on JAMK's self-evaluation report, interviews, mechanical engineering department's curriculum and course descriptions, the programme is designed so that its outcomes should correspond with the need of the students' ability to conduct literature searches and use databases and other sources of information, design and conduct appropriate experiments, interpret data and draw conclusions and show workshops and laboratory skills. There is a path for the development of investigations skills for the students in mechanical engineering, in both specialisations.

In order to practice the ability to conduct literature searches and to use databases and other sources of information, the curriculum has courses where students are required to write reports, which includes analysis of theories regarding the subject of the course. In engineering studies, the students seem to face this in almost every course of the programme.

The curriculum also includes courses where students are required to work in the laboratory, where they are required to design and conduct appropriate experiments, interpret the data and draw conclusions. These needs were shown to be filled for example in the description of physics and material engineering courses and also in the reports made by students.

In their third and fourth years, students are expected to conduct more advanced project work and courses that include working in the workshops, for example in Process development and Production automation courses. In these courses the examination papers and coursework were well produced and presented.

However, during the interviews and the tour of facilities it became clear that the students could benefit from more hands-on hours using machines. This need of practical skills had also been brought up by the students in the course feedback.

Engineering practice

- *The ability to select and use appropriate equipment, tools and methods;*
- *The ability to combine theory and practice to solve engineering problems;*
- *An understanding of applicable techniques and methods and of their limitations;*
- *An awareness of the non-technical implications of engineering practice.*

The programme is designed in close connection to the local industry and is heavily influenced by it. Also international requirements influence the programme design. Students must spend approximately five months (30 ECTS) working in industrial placements and must pass this section of the course to obtain their degrees. Typically, this placement is completed as one continuous practical training session during the third year. This approach was appreciated by industry, as in this time students are able to learn enough to also benefit the company. A significant number of students either work abroad during their placement or attend a university abroad for one semester.

The students are given the opportunity to combine theory and practice to solve engineering problems in a number of subjects during this course. Analysis of the evidence provided and interviews with the students clearly indicates that the students have an understanding of applicable engineering techniques and their limitations.

Students are also taught by a number of international academics and practicing engineers who provide real world projects for the students to analyse and the students get to work on the RDI projects.

Students were also aware of ethical issues and "soft" skills that are often missing in engineering degree programs. However, there seemed to be a lack of some health and safety signage in the labs and it was not clear that equipment used in the laboratories required a risk assessment to be completed. The programme should consider introducing (or if they exist, making them visible for students) such ethical requirements as risk assessments are often ignored by engineers.

The students interviewed were confident that they were prepared for working in industry. The subjects that the students studied during their degree were found to contain a good combination of engineering relevance and basic engineering background. The students appeared to know when to use appropriate equipment and methods to solve specific problems.

Transferable skills

- *Function effectively as individuals and as members of a team;*
- *Use diverse methods to communicate effectively with the engineering community and with society at large;*
- *Demonstrate an awareness of the health, safety and legal issues and responsibilities of engineering practice, understand the impact of engineering solutions in a societal and environmental context, and commit themselves to the professional ethics, responsibilities and norms of engineering practice;*
- *Demonstrate an awareness of project management and business practices, such as risk and change management, and understand their limitations;*
- *Recognise the need for and have the ability to engage in independent, life-long learning.*

In the mechanical engineering curriculum there are several options which develop students' transferable skills. For example, all students participate in JAMK's innovation week where they work in multi-disciplinary teams. Later on in their studies there are many courses where students must work as teams and manage different projects in a structured way. In these projects students learn not only the subject matter but also team work, project management, leadership in general, communication skills and holistic thinking.

The students also have possibilities to develop their entrepreneurial skills as this is a strategic focus area of JAMK and thus there are many options (such as incubator activities and possible small financial support for prototyping) available for the students. However, the entrepreneurship courses were not very popular among the mechanical engineering students and only a couple of the interviewed students had followed the subject beyond the compulsory courses.

As some courses in the programme are being conducted in English language and some others in CLILL –style (content and language integrated language learning), it can be said that communication skills in English especially are developed well throughout the programme. The possibilities to study some courses in English together with the exchange students, or even to complete one whole academic year in Germany in Esslingen in order to acquire a double-degree, improve the students' multicultural skills.

Standard 6: Teaching should be delivered according to planning.

The review team evaluates the fulfilment of the standard to be **acceptable**.

It is clear that JAMK takes its teaching very seriously when applied to the mechanical engineering programme. Any feedback recorded whether from the industrial panel, past graduates or current students, is used in the design of the curriculum. The new curriculum is decided each year and the delivery of each module was found to conform closely to the original curriculum. The only event which might cause teaching to deviate from the original plan is if student feedback suggested that a new route was required. Each student also prepares a personal learning plan where they choose the topics that they are going to study. The students that we met agreed that the programme that they has signed up to was as described and that they had achieved the learning outcomes and opportunities that they had expected from completion of this course. As discussed in the self-evaluation report, each lecturer completes a detailed weekly work plan according to the course schedule and introduces it to the students at the beginning of the course. The lecturer also has to follow up the weekly work plan and sign each week completed.

Standard 7: Counselling and support workload that is offered to the students should be adequate to support the students in achieving the specific learning outcomes of the courses.

The review team evaluates the fulfilment of the standard to be **acceptable**.

As described in the self-assessment report and verified in the interviews, JAMK offers very good support services for the students. This is achieved through a multidisciplinary well-being team, which also has members from outside of JAMK. The students also undertake a personal learning plan which is agreed with their tutor. The students appear to have a number of opportunities to give feedback to their tutors and to obtain assistance when required. Some of these opportunities include innovative online methods, but also traditional open door policies. The students that were interviewed were satisfied with the support that was available to them during their time at JAMK. This was especially evident in the area of international placements where the systems in place made it very easy for students to travel as part of their studies.

Students also have annual meetings with the staff where they discuss their career path. In these meetings, opportunities to study abroad or to study foreign languages are discussed. Also the possibility to do practical training and to gain work experience is discussed. Students have to make their own study plan until they graduate, guided by their tutors which monitor and advise them in their career choice.

While the accreditation visit was taking place, there was an opportunity for students to give anonymous feedback in the canteen regarding any issues that the students might have had. Some examples included difficulties with particular subjects to more social related activities.

Standard 8: Examinations, projects and other assessment methods should be designed to evaluate the extent to which students can demonstrate that they have mastered the learning outcomes for individual courses and the programme outcomes, respectively, throughout the programme and at its conclusion.

The review team evaluates the fulfilment of the standard to be **acceptable**.

The sample evidence seen during the review visit confirmed that the examinations, projects and other assessment methods are designed to evaluate the students' learning outcomes in courses and in the entire programme. All standards and rules concerning the assessment of students' performance in the course, project and programme are shown transparently and are publicly available for students to access.

The assessment scale in engineering studies in Finland is from 0 (no pass) to 5 (excellent). The scale has been described in greater detail for each course in the course descriptions, which are presented in the publicly available study guide. The assessment criteria are also given to students at the beginning of each course. Also, transferable skills are assessed separately in certain courses and when it is the case, it is explained in the course descriptions.

The targeted competencies are clearly assessed during the degree. A number of different assessment techniques are used to ensure that the students achieve the intended learning outcomes. Some of these include online assessment, others are traditional exams and some are project based assessments. Thus, the focus of assessment is not only on exams but also on exercises, laboratory work and project performance. The final grade of a course is usually a combination of these.

Students are examined on numerous problems during their degrees which they must solve using available techniques.

Especially in project courses students are demanded to write project reports including the whole process from the project planning to implementing and presenting the results of the project task. Reports are completed in detail, which gives teachers the possibility of evaluating a variety of students' skills.

These reports showed the students' ability to search information from literature, databases and other sources. Reports studied by the review team also included descriptions of experiments, from designing the experiment to executing them and presented the conclusions of these experiments. Many of those were completed virtually or in practice in laboratories and workshops.

The thesis is assessed by several persons meaning the student her/himself, one peer pair (who the student recruits him/herself), teacher and the company which has given the topic. The criteria for the different grades of the thesis are written clearly and given to the students.

The students are made fully aware of the assessment metrics in each subject and are able to discuss the results openly with their tutors. Although it is possible to formally complain about the received grade of a course or the thesis, there was no case found where a student had formally complained, as evidenced in the material provided and from meetings and discussions with staff and students.

Strengths, good practice and areas for further development regarding the Section 2.2: educational process

The team notes the following **strengths** in this section:

- JAMK's web pages clearly indicate the systematic method used for planning the curriculum.
- Good course descriptions are made available with clear assessment guidelines
- There exists a long tradition with industry related projects and good industry network now feeding the "system" with new projects each year.

- Some courses are taught in English for all students, improving the students' exchange rate which in turn improves the strategic internationalisation target of the whole programme.
- Close cooperation with regional industry in student and RDI projects which helps students achieve industrial contacts and teachers to ensure that their knowledge up-to date
- The international options available for students for both industry projects and exchange studies are very strong
- Staff members have the possibility of applying for extra funding for teaching experiments or to prepare research proposals.
- An active international teacher exchange was found to exist at JAMK.

The team would like to highlight the following **good practice** in this section:

- Joint course of Production Management and Logistics where students from two separate departments are put together to work in multidisciplinary teams.
- International Product Development course where Finnish and foreign students work in international project teams solving real life industrial product development cases.
- Intention and willingness to develop mathematics teaching, e.g. mathematics teaching in 3 different modes depending on students' capabilities and new tutoring material for maths being developed (books and virtual video material).
- Use of virtual teaching in the machine elements course.
- Course plan is a good tool from a quality management viewpoint

The team sees the following as **areas for further development** in this section:

- Entrepreneurship development is one of JAMK`s strategic focus areas. It still remains somewhat unclear if the mechanical engineering students have a real option to choose this study path in practice. It could be beneficial if this option would also be shown in the visualisation of the curriculum structure.
- Closer co-operation with JAMK`s Team Academy or other departments might be a good possibility for developing the entrepreneurship and innovation skills of engineering students.
- The amount of students' laboratory work hours could be revisited. There is some doubt about the sufficiency of the amount of the practical hands-on work in the laboratory.
- In further development of the curriculum, the requirement for chemistry competence and programming skills should be analysed more deeply.
- Increased subjects and equipment in the area of materials and materials analysis to stay in line with the existing RDI projects.

2.3 Resources and partnerships

Standard 9: The academic staff should be sufficient in number and qualification to accomplish the programme outcomes.

The review team evaluates the fulfilment of the standard to be **acceptable**.

Academic staff members were found to be educated to a high technical level and very dedicated to the education of their students. During interviews, academic staff members were very familiar with the programme and were clearly able to answer questions relating to the students, the programme and the industrial placements and final employment of their graduates.

Academic staff offer testing and support to industry which ensure that they are abreast of the latest technological developments in their field and are able to pass that information on to students. As detailed in the self-evaluation report and probed at interview, staff members are encouraged to partake in continued professional development through RDI projects, assignments abroad, cooperation with working life, conferences, forums and training.

Standard 10: The technical and administrative support staff should be sufficient in number and qualification to accomplish the programme outcomes.

The review team evaluates the fulfilment of the standard to be **acceptable**.

During the evaluation, the review team met with a range of support staff who enthusiastically discussed their role in supporting the degree programme. As described elsewhere in this document, the support for internationalisation was found to be very strong which has resulted in a very high proportion of students spending at least one semester abroad.

The library facilities were found to be of a high standard with easy access through electronic means and also a range of current books and periodicals to help students to research their chosen topics. Administrative staff members were found to be sufficient in quantity as were technical staff members who manage laboratories and technical equipment.

Standard 11: The classrooms, computing facilities, laboratories, workshops, libraries and associated equipment and services should be sufficient to accomplish the programme outcomes.

The review team evaluates the fulfilment of the standard to be **acceptable**.

Based on interviews, the tour of facilities, leaflets and material available on the JAMK webpage, the review team concludes that the classrooms, computing facilities, laboratories, workshops, libraries and associated equipment and services are sufficient to accomplish the

programme outcomes. Machines, equipment and software are chosen to correspond with industrial needs, so that it is possible for the students to become familiar with them during their studies. The latest addition to the mechanical engineering workshop was Protolab, which is meant to be used in quick prototyping and small manufacturing work. This was seen as a positive direction for the development of the learning environment. However, the materials laboratory is currently rather limited and could be improved.

The equipment available to search information and conduct experiments is also chosen to meet the educational and industrial needs. Libraries and associated equipment and services in order to search for information, are available to students widely and provide good premises and tools for learning.

Laboratories and workshops associated equipment aren't so well available to students, as it was widely requested by the students to be able to use laboratory machines more in practice and in other times outside the official course scheduled hours. However, industrial representatives felt that the graduates do have the required level of practical skills.

Standard 12: The financial resources should be sufficient to accomplish the programme outcomes.

The review team evaluates the fulfilment of the standard to be **acceptable**.

The mechanical engineering programme at JAMK is funded by the Finnish government. The Ministry of Education and culture allocates the funding to universities of applied sciences according to their performance on the key performance indicators which the Ministry of Education and Culture has set. Students pay no tuition fees.

The financing position of JAMK is strong as JAMK Ltd. has made profit. The annual turnover of JAMK Ltd. in 2014 was 58,1 M€ and the annual budget for running the Industrial Engineering Department in 2015 is 4,8 M€ from which 3,7 M€ comes from the Ministry and the rest 1,1 M€ from RDI projects and selling services etc. other income. The budget for 2015 is smaller than for the previous year. Inside JAMK the budget is allocated to departments according to their performance on the most important KPIs. The department of Industrial Engineering has 300 000 € for purchasing services, 100 000 € for materials and 80 000 € for staff (44 persons) training which means approximately 1800 € per person per annum.

The separate investment budget for the laboratory equipment remained unclear. EU and industry funded RDI projects seem to have quite a big role in financing the laboratory and research equipment at JAMK. As the government funding probably will decrease rather than increase in the future, it is positive that the mechanical engineering programme has such strong connections with local industry. This is achieved through joint RDI and research projects have been found and will probably be found within this network in the future as the faculty has close connections to the local industry and there is a tradition to conduct this kind of co-operation. This will help the programme to keep the laboratory and research equipment updated.

Overall, the financial resources are sufficient for the students to accomplish the targeted competences.

Standard 13: The partnerships that the HEI and the programme have with external parties should contribute to accomplishing the programme outcomes and facilitate the mobility of the students.

The review team evaluates the fulfilment of the standard to be **acceptable**.

Regional industrial partnerships and cooperation is well established and very highly appreciated by all involved. International partnerships and cooperation with foreign research institutions and other higher education institutions are visible and have produced positive results in many aspects.

Cooperation between the programme and partner schools in other countries is extensive. There was strong evidence shown to the review team, for example in the form of course reports of the International Cooperation Project, RePCI. The mobility of students is excellently supported ensuring that it is easy to study abroad. Courses studied in foreign schools are acknowledged in JAMK directly with similar courses. This ensures all exchange studies are made part of the degree and makes the decision-making easier for students. The review team sees this as good practise.

Possibility for improvement was noticed in the collaboration between Finnish and foreign students during the studies, which came up in the interview with alumni. It would be good to combine local and international students more in practical projects in addition to traditional lectures.

Based on the interviews, regional mobility of the students was noticed to be strong. JAMK and the industry work in close collaboration in order to provide possibilities for the students to practise their knowledge in an industrial environment, working with real engineering problems during their studies. This is also a mandatory part of the curriculum; students conduct their practical training typically during their third year of studies.

The possibility for the students to apply for RDI projects completed with industry by JAMK's RDI-staff was seen as positive, although rare opportunity. Students can be chosen to these projects depending on their level and skills regarding the subject of the project. As an example, during the tour of facilities and in the evidence room, the review team saw evidence of two projects where students were involved in developing a machine for testing dynamic loads and equipment for performing tests in cold temperatures.

Strengths, good practice and areas for further development regarding the Section 2.3: resources and partnerships

The team notes the following **strengths** in this section:

- Staff are well educated and competent (also pedagogically) and have strong connections with local industry (industrial background is an obligatory requirement for teachers) and teachers are willing and capable of conducting RDI work and research as well as publishing conference and peer-reviewed journal articles.
- The organisational culture fosters internationalisation and the international advisor is very active resulting in excellent internationalisation figures for the programme (both regarding staff and student exchange figures).
- Strong and well established international partnerships with active partners exist and they have resulted in many international joint projects.

The team would like to highlight the following **good practice** in this section:

- Organisation of the IFME and its conferences and the RePCI project.
- International cooperation in project courses

The team sees the following as **areas for further development** in this section:

- It remains unclear how often the technical services facilities (for example the calibration centre) are being used in BSc education now. It could be useful for the competence development to let the undergraduates also have some access to these facilities.

2.4 Assessment of the educational process

Standard 14: The students admitted to the programme should have the right prerequisite knowledge and attitudes to achieve the programme outcomes in the expected amount of time.

The review team evaluates the fulfilment of the standard to be **acceptable**.

The entrance requirement for the programme is either vocational secondary education or general upper secondary education. In practice, students from both backgrounds enter the programme.

The entrance examination is a maximum of 4 hours written exam. It is measured by studying the capacity and suitability to engineering studies, including logical reasoning, mathematics and physics or chemistry. In this test, a student must achieve at least 10 points of the maximum value of 40 points. The test results are valid only for only one admission session.

The applicant may choose which university of applied sciences in Finland they want to participate in the exam, so the place where the applicants want to take the exams is mandatory. By participating in the entrance examination, the applicant receives a test result which is valid for all engineering programs as well as laboratory analyst programs in Finland.

The conclusion after meeting with the students is that they are satisfied with the admission requirements. Last year, 2014, DMPE had 98 student applications for 40 study places, so the attraction rate (1. place applicants/number of study places) of the degree is 2.45.

Both the interviewed staff and students realise that undergraduates will have different skill levels depending on whether their background is from the general upper secondary or the vocational secondary education. The students from the general upper secondary side typically have stronger skills in mathematics, physics and chemistry while the students coming from the vocational institutions were said to have good practical skills. Also, some students have been working for many years between graduating from the vocational institution and starting the studies in JAMK. Variation in the prerequisite knowledge was, however, not seen as a big problem, as the first courses on mathematics and physics have been designed to take the differences between these groups into account.

Standard 15: Students' career choices should attest to the extent to which the students achieved the programme outcomes in the expected amount of time.

The review team evaluates the fulfilment of the standard to be **acceptable**.

In 2014 the average time taken to complete the programme was 4.7 years. According to the interviews, the most important reason for students taking more than the targeted four years to complete the degree was due to students working in tandem with their studies. In the self-evaluation report, the programme states that it is now paying special attention to students in the final stages of their studies to support them to ensure that they graduate on time.

However, the drop-out rate of the programme is relatively high, albeit roughly at the same range with other engineering programmes at JAMK. It was found to be lower than in the Finnish universities of applied sciences in general. One of the main reasons given for this in interviews, by both staff and students, was that the students had noticed during the first year that in the end, the programme was not right for them. Taking this into account, the programme should pay attention to the marketing and admissions information in order to lower the drop-out rate and to attract the right students.

Standard 16: The graduates should enter an occupation corresponding to their qualification.

The review team evaluates the fulfilment of the standard to be **acceptable**.

According to Opala, survey and follow up surveys completed one and five years after graduation, graduates had mainly entered occupations corresponding to their qualification. In the follow-up completed five years after graduation, those who studied mechanical engineering in JAMK felt that they had more opportunities to utilise acquired competencies in their current work than students who studied in the other fields of technology, communication and transport in JAMK.

Also, in the follow-up completed five years after graduation, graduates are asked about years of employment and years of unemployment after graduation. Both of these measures indicated strong results and are on a higher level when compared to the other fields of technology, communication and transport in JAMK. Based on the interviews with graduates and alumni and the follow-up feedback, in most cases graduates enter an occupation corresponding to their qualification immediately after graduation or in quite short time and feel that the education they received matched well with the employment gained.

Standard 17: The stakeholders (graduates, employers, etc.) should confirm that the programme achieves its educational objectives.

The review team evaluates the fulfilment of the standard to be **acceptable**.

It was shown very clearly that the programme achieves its educational objectives. Opinion between interviewed groups was very similar; that the programme achieves its educational objectives. This was especially highlighted by the interviewed employers and alumni.

In the follow-up completed one year after graduation, graduates opinion showed that they felt mainly satisfied with how the programme achieves its educational objectives, but graduates answers regarding sufficient knowledge and skills for working as an entrepreneur had wider distribution. This was also noticed during the interviews: the achievement of educational objectives in entrepreneurship has still room for development.

In the follow-up completed five years after graduation, those who studied mechanical engineering in JAMK felt that they had more opportunities to utilise acquired competencies in their current work than students who studied in the other fields of technology, communication and transport in JAMK. In the same follow-up mechanical engineers were also shown to be more satisfied with the degree in relation to a career, than the reference group in other fields of technology in JAMK.

Strengths, good practice and areas for further development regarding the Section 2.4: assessment of the educational process

The team notes the following **strengths** in this section:

- Correspondence between basic mechanical engineering education and the needs of industry
- Graduates are well capable of entering local and international industry after completing their degrees.

The team sees the following as **areas for further development** in this section:

- The programme should pay attention to the marketing and admissions information in order to lower the drop-out rate and to attract fully committed students.

2.5 Management system

Standard 18: HEI's and the programme's organisation and decision-making processes should be fit to accomplish the programme outcomes.

The review team evaluates the fulfilment of the standard to be **acceptable**.

The organisational structure of JAMK consists of four schools and an administration unit that provides shared support services for all schools. JAMK has a rector who is also the president of the JAMK Ltd. JAMK has also a board of directors which is responsible for the administration of the corporation.

The school of technology has four departments and within these departments team based leadership is employed. RDI activities as well as professional services are situated inside each department. The operations are guided by formal documents such as laws, JAMK's degree regulations and ethical principles and JAMK's quality system which include JAMK Quality Manual, JAMK Process Manual and school-specific Quality guides.

A well-defined strategy exists for the whole JAMK and all the schools implement it in their education and other operations. The division of power and decision-making is well-defined in the organisational descriptions.

Standard 19: HEI's and the programme's quality assurance systems should be effective enough to ensure that the students achieve the programme outcomes.

The review team evaluates the fulfilment of the standard to be **acceptable**.

According to the quality manual, JAMK's quality management is based on continuous improvement and consists of four elements: 1) planning, 2) action, 3) follow-up and evaluation and 4) quality improvement. Quality planning documentation has been divided into three levels: 1. Quality Manual 2. Process Manual 3. JAMK operational guidelines and forms, Quality guides of the schools.

JAMK's and the programme's quality assurance systems showed evidence of being effective enough to ensure that the students achieve the programme outcomes. The curriculum is evaluated each year via a systematic process and future competence needs of working life are continuously examined. Evidence was strong especially in course descriptions, schedule/plan and in the gathered course feedback.

The students are treated in a professional manner where their course feedback is collected systematically and is analysed and taken into account quickly. Where required, actions are executed immediately. Interviews with students confirmed that if they give feedback, it is analysed and development actions were implemented immediately when possible by the teacher. The course feedback was felt to be the most important part of quality management regarding teaching and course content.

In addition, the mid-term course feedback provides timely information on how well a course is reaching its objectives, and allows for the teacher to adapt the course during the implementation.

JAMK also asks the opinion of employers on the graduates' education systematically via the advisory board which consists of representatives from eight significant employers for mechanical engineers, one representative from the regional development company and six representatives from JAMK's department of mechanical engineering.

Continuous development in the content of the courses and curriculum was visible and fast. If industry stated reasons to present additions to the curriculum or course content, it is analysed and executed quickly. As one example which was seen from the advisory board meeting memoranda, the industry representatives had noted that production students should be familiar with enterprise resource planning (ERP) systems. This need was analysed and the teacher of the particular Operations Management course had taken this immediately into action, by increasing the amount of teaching of ERP-systems in the course plan.

Standard 20: The results for the delivery process, students and graduates should be analysed and used to promote the continuous improvement of the programme.

The review team evaluates the fulfilment of the standard to be **acceptable**.

JAMK collects feedback from the students and other stakeholders in a systematic and very comprehensive way. The curriculum development work is given clear guidelines by the management. Progress of the students is monitored on a regular monthly basis. Corrective actions are made based on the students' mid-term feedback as well as course feedback and normal student feedback. The whole curriculum is revised roughly every five years or whenever necessary based on feedback. As a conclusion, the quality work and quality assurance systems have high priorities in JAMK and in the degree programme of mechanical engineering and the quality culture can be clearly observed in the development work.

Standard 21: Needs, objectives and outcomes, the educational process, resources and partnerships, and the management system should be periodically re-examined.

The review team evaluates the fulfilment of the standard to be **acceptable**.

JAMK degree programmes are reviewed every year through a process that involves the Educational Development Manager of JAMK, who coordinates the whole process, the Internal Board of JAMK, which approves the basis curricula, the Advisory Board, which takes in consideration student feedback, the Head of Department, who defines the structure of content of the degree programme together with the Head of Programme, and the Vice Rector, who approves the curriculum.

The quality of the degree programme is assured through a procedure called "cross-evaluation of the degree programmes". This procedure is focused on deepening the pedagogical view, expanding the understanding about learning environment and the sense of community in the degree programme.

The needs of the interested parties and how the objectives and outcomes of the programme relate to the identified needs are re-examined mainly in the regular Advisory Board meetings.

Regular participation in external assessments of the programme and the quality system also support the development of the management system.

Strengths, good practice and areas for further development regarding the Section 2.5: the management system

The team notes the following **strengths** in this section:

- Quality culture and an aim for continuous development
- Very high standards placed on quality assurance with clear system for quality planning documents
- Systematic feedback collection from students, alumni and external stakeholders
- The level of commitment from the advisory board
- Course feedback which leads to actions

The team would like to highlight the following **good practice** in this section:

- Mid-term course feedback is very useful and easy to collect
- Crumble week for giving straight feedback

The team sees the following as **areas for further development** in this section:

- It could be useful for the programme to create better ways for smaller companies to affect the curriculum design in addition to the advisory board.

3
Overall evaluation of the programme

According to the review team's view it is recommended that the **programme pass the review without reservation** as all individual standards are evaluated as being acceptable.

Upon reviewing the programme, the team notes the following **key strengths**:

- Close cooperation with regional industry in student and RDI projects which helps the students get industry contacts and the teachers to keep their knowledge up-to date
- The international options available for students for both industry projects and exchange studies
- Active international teacher exchange
- Students' voice is heard through discussions and feedback surveys and has an effect on the course level

The team would like to highlight the following **good practice** of the programme:

- International Product Development course where Finnish and foreign students work in international project teams solving real life industrial product development cases.
- Course plan is a good tool from the quality management viewpoint
- International cooperation in project courses
- Mid-term feedback is very useful and easy to collect.

The team sees the following as **areas for further development** of the programme:

- Students would benefit from more hands-on laboratory experience
- The programme should pay attention to the marketing and admissions information in order to lower the drop-out rate and to attract the right students
- In the further development of the curriculum the need for chemistry competence and programming skills should be analysed more deeply.
- Increased subjects and equipment in the area of materials and materials analysis to stay in line with the existing RDI projects.

4
FINEEC Committee for Engineering Education's decision

In its meeting on 28 May 2015, the FINEEC Committee for Engineering Education decided, based on the proposal and report of the review team, that the Degree programme in Mechanical Engineering at JAMK University of Applied Sciences meets the FINEEC review criteria. The programme has been awarded a EUR-ACE Bachelor quality label that is valid until 28 May 2021.

The Finnish Education Evaluation Centre (FINEEC) is an independent, national evaluation agency responsible for the external evaluations of education from early childhood education to higher education in Finland. It implements system and thematic evaluations, learning outcome evaluations and field-specific evaluations. Moreover, FINEEC supports providers of education and training and higher education institutions in matters related to evaluation and quality assurance, as well as advances the evaluation of education.

Engineering programme review is a degree programme specific evaluation that can lead to the European EUR-ACE Label. The review aims to support the enhancement of quality in engineering degree programmes and increase the international comparability and recognition of engineering degrees within Europe. The review is voluntary for Finnish higher education institutions and degree programmes. This report presents the process and results of the review of the Degree Programme in Mechanical Engineering at JAMK University of Applied Sciences in Jyväskylä, Finland.

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Finnish Education Evaluation Centre
P.O. Box 28 (Mannerheiminaukio 1 A)
FI-00101 HELSINKI

Email: kirjaamo@karvi.fi
Telephone: +358 29 533 5500
Fax: +358 29 533 5501

karvi.fi