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A Competence Based Framework for Engineering Education

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The Engineer - community committed creative and empowered, with the ability to actively contribute to challenges of the future! For many young people, their choice of education is based on emotion and the identity they want to build, rather than rational, logical choice. They want to realize themselves and many of them want to "do something related to sustainability/ environment. http://www.naturfagsenteret.no/prosjekt/vis.html?tid=1519408. For our challenges to obtain sustainable solutions, knowledge in science and technology is important, and education programs within these areas must attract young people. This paper is about the development of a new competence based framework for Norwegian engineering education on bachelors level, and the challenge to make this education attractive through meeting the expectations of young people and show them how they can realize themselves through engineering and that they through the engineering profession can contribute to sustainable future changes. The vision above, as well as background, analysis, survey and materials essential for the project, its process and its results are presented and discussed in the paper.

NOKUT – the Norwegian Agency for Quality Assurance in Education performed an evaluation of Norwegian engineering education in 2008. In 2009, a national qualifications framework for higher education, based on The European Qualifications Framework for higher education, was adopted. On this background the Norwegian Ministry of Education and Research initiated a project to revise the framework for engineering education. The work was initiated in 2010, and the framework will be fully implemented starting the academic year 2012/2013. An implementing process focusing on cooperation and concentration, a main goal within Norwegian higher education, is planned and is central in exploiting the potential given by the new framework. It was a goal of the committee, appointed by the ministry, to develop a framework which made it possible to strengthen totality, systems thinking and diversity in engineering education, with the vision that engineers in the future are seen as "community committed, creative and empowered, with the ability to actively contribute to challenges of the future". Other important goals were to attract new student groups, particularly women and to develop an education which is integrated and holistic and make use of a much broader variety of teaching and learning strategies than commonly used by today's engineering education. The paper presents the process and the results of developing the new framework for Norwegian engineering edu-

cation, consisting of mandatory regulations and supporting national guidelines. Competences; learning outcome, described as knowledge, skills and general competences for all engineering candidates regardless of engineering area is the central part of the regulations (examples in table 1).

Knowledge	The candidate has extensive knowledge that provides a comprehensive system approach to engineering in general, with specialization in own engineering subject	LU-K-1
Skills	The candidate can identify, plan and carry out professional engineering projects, assignments, tests and experiments, both independently and in teams.	LU-F-3
General expertice	The candidate has understanding of environmental, health, social and economic impact of products and solutions within their field and can put these in an ethical perspective and a life cycle perspective.	LU-G-1

Table 1. Examples of learning outcome for Norwegian engineering candidates

Many of the expected learning outcomes, competencies, for engineering candidates will result in both new ways of learning and evaluating as well as the need to build up new knowledge, skills and general expertise that are only poorly covered within today's study programs.

The following topics, established based on analysis of background material from both theory and empirics, the mandate and objectives was central: corporate social responsibility, ethics and the engineer's role in society, systems thinking, integration of theory and practice, co-operation and student mobility, nationally and internationally, international term, admission, degree and transition to master level, interdisciplinarity, innovation and entrepreneurship, research based education as well as environment and ethics.

A successful implementation of new engineering education will provide an engineering education with the following expected characteristics: Integrated and holistic education, In front by means of professional updating, Updated and varied learning- and evaluation methods , Research and development orientation, Professional competence and practical skills, International expertise, Interdisciplinarity, innovation and entrepreneurship, Study effort and coping, Engineering formation. Examples of indicators are shown in table 2.

Characteristics	Indicators
Integrated and holistic education	Good academic progress in the engineering academic courses that build on the qualifications in science and social topics.
Updated learning- and evaluation methods	Teaching methods to activate critical, reflective and conscious thinking.
Interdisciplinarity, innovation and entrepreneurship	Teaching methods and evaluation methods to stimulate collaboration across engineering disciplines and interdisciplinary approaches in a broader perspective.
Engineering Formation	The program and its implementation contribute to social responsibility, environmental awareness, ethical responsibility and understanding of the consequences of technology. The program and its implementation develop high professional qualifications, understanding of the systems view and respect for other disciplines

Table 2. Example of characteristics and indicators of quality

Even if the full implementation starts the academic year 2012/2013, five institutions started fall 2011. Experience from these institutions already giving programs in accordance with the framework, show more motivated and engaged students, and more interaction between staff. An interesting further study is to follow and evaluate results from broad implementation, particularly how the use of learning outcome influence content, learning and evaluation. ■