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List of terms

English/Norwegian terms:

**Institutions:**
- Ministry of Education and Research
- Kunnskapsdepartementet
- National Committee for the Engineering Education
  *Nasjonalt råd for teknologisk utdanning (NRT)*
- Norwegian Agency for Quality Assurance in Education
  *Nasjonalt organ for kvalitet I utdanningen (NOKUT)*
- Norwegian Association of Higher Education Institutions
  *Universitets- og høgskolerådet (UHR)*
- Norwegian State Educational Loan Fund
  *Statens lånekesse for utdanning*
- Norwegian Institute of Technology
  *Norges tekniske høgskole (NTH)*
- Norwegian University of Science and Technology
  *Norges teknisk-naturvitenskapelige universitet (NTNU)*
- Research Council of Norway
  *Norges forskningsråd (NFR)*
- SINTEF
- Student Welfare Organization
  *Studentsamskipnaden i Trondheim (SIT)*
- TEKNA
- Universities and Colleges Admission Service
  *Samordna Opptak*

**Other terms:**
- Act relating to Universities and University Colleges
  *Universitetsloven*
- Adjunct professor
  *Professor II*
- Assistant professor
  *Amanuensis/universitetslektor*
- Fixed-term 20 % position, normally for five years, with mainly teaching duties. Many adjunct professors in engineering work at SINTEF or in industry.
- Academic position with mainly teaching duties (for staff without a doctoral degree).
Permanent academic position devoting on average half the time to research and teaching. After a national peer-review process many became full professors.

The engineering students typically follow four courses per semester of 7.5 ECTS each.

The reports of the Committee on the structure of the engineering education (1993) and its non-technology components (2003) have largely determined the current engineering education.

Official statistics on HE operated by the Norwegian Social Science Data Services (NSD) on commission from the Ministry of Research and Education.

Head of the Faculties, There are 7 Faculties at NTNU.

The Dean of Engineering Education attends the Deans meetings with Rector and is the chairman of the Executive Committee for the Engineering Education.

Basic level academic unit under the leadership of elected Heads of Departments. There are 53 Departments at NTNU organized within 7 Faculties.

The Department is responsible for the programme of study under the same name and is part of the SVT Faculty.

NTNU applies the European ECTS standard. 60 credits equal one year of full-time study.

The Committee is chaired by the Pro-Rector for Education and Quality of Learning. It is appointed by Rector and serves as an advisory body to the Rector.

The Committee is chaired by a Dean appointed by Rector and reports to the UU. The Committee is to promote quality, equal opportunities and a common structure in the engineering education suitable to the needs of the society.

A one-semester project for 4th year students

Academic unit under the leadership of appointed Deans reporting to Rector. There are 7 Faculties at NTNU with 53 Departments.
Main profile

The NTNU main profile is in natural sciences and technology.

Internship

In MSc in Engineering at NTNU there is compulsory 12 weeks internship in relevant industry or institution during the summer recess.

Learning outcome

A five year integrated programme of study leading to an MSc Degree in Engineering.

Major in the programme of study

Non-technological courses in the engineering degree.

Programme of study

NTNU has 16 programmes of study in engineering. They are five-year integrated programmes leading to a MSc Degree in Engineering.

Quality Reform

Reform of Norwegian higher education responding to the Bologna Process implementing the bachelors and Master’s degrees, the ECTS system and the A to F grading scale in Norway.

Rector

Rektor

Subject

Fag

Universities

Higher education institutions offering PhD studies in a number of scientific areas

University Colleges

Higher education institutions located in all counties offering studies primarily at bachelor’s level, but with an increasing number of master’s (and even PhD study).

Upper Secondary Schools

The Curriculum Development Committee report “Vilje til forbedring” (NTH, August 1993) or “Engineering Education in the 21st Century” (English Summary).

VK1 Virksomhetskomiteens rapport no 1 (1993)

VK2 Virksomhetskomiteens rapport no 2 (2003)

The Curriculum Development Committee report “Teknologutdanning med perspektiv” (NTNU, July 2003) or “Engineering Education with a New Perspective” (English translation).
Preface

NTNU is the nationally leading higher education institution in technology research and education in Norway. The university is responsible for almost 80% of the MSc in Engineering Education and has been given the national responsibility for graduate engineering education. It is thus vital to the Norwegian society that NTNU offers an educational programme of high international academic standard and pedagogical quality.

The NTNU quality assurance system focuses on continuous improvement of educational courses and programmes. It is, furthermore, presupposed to conduct a more comprehensive evaluation of the learning objectives, programme structure and academic profile of the educational programmes every 5 - 6 years. The MSc in Engineering is undergoing such a comprehensive evaluation in 2007-2008. The objective of the evaluation is to further develop our MSc in Engineering Education with high international quality and relevance to the needs of working life.

Rector Torbjørn Digernes has conferred upon the Executive Committee for the Engineering Education (FUS) to serve as the steering committee for the evaluation:

- Bjørn Torger Stokke (Chair, Dean of Engineering Education)
- Olav Fagerlid (Vice-Dean Faculty of Social Sciences and Technology Management)
- Anne Borg (Vice-Dean Faculty of Natural Sciences and Technology)
- Svein Remseth (Vice-Dean Faculty of Engineering Science and Technology)
- Kristian Seip (Vice-Dean Faculty of Information Technology, Mathematics and Electrical Engineering)
- Øyvind Aass, Student representative
- Edina Christin Ringdal, Student representative
- Åge Søsveen (Secretariat, Senior Adviser, Student and Academic Division)

When designing the evaluation process, the involvement of academic staff and students as well as the management of each programme of study has been emphasized to foster ownership of the results of the evaluation and accept future changes. The internal evaluation process started in February 2007 when four thematic groups were appointed to assess generic issues, notably the programme structure, the non-technology content in the programme, international benchmarking and recruitment of students. Their reports were presented at a seminar 20-21 March 2007 and discussed with the heads of the engineering programmes. At the seminar the objectives and key issues of the internal and external evaluation were also discussed and identified.

There are currently 16 MSc in Engineering Programmes at NTNU, and each of them conducted their own self-evaluation from May through November 2007 based on a common mandate issued by FUS. The perception of key issues and potential for improvement varies between the programmes, and FUS has therefore emphasized that the self-evaluations should be seen as a tool to make improvements in each individual programme of study.

In December 2007, Rector formally appointed an international review team with a mandate to deliver their assessment and recommendations by September 2008. The external evaluation will be based on this self-evaluation report and key documents as well as interviews with stakeholders and general information obtained by the review team during a pre-visit and review visit at NTNU in spring 2008. The external evaluation will serve as essential input to
FUS when the committee is to develop and present a plan for the further development of the engineering education to the NTNU Board in the autumn 2008.

FUS has followed the internal evaluation process closely, determined the general structure and content of the overall self-evaluation report. This report includes reports on each individual MSc in Engineering Programme (volume II) and an overall report (volume I) where the main issues in the evaluation are identified based on the four thematic reports mentioned above and the reports of the individual engineering programmes. The report also provides some background information to enable the review team to better understand the engineering education at NTNU and the context in which it operates. Key documents have been translated to English and made available to the review team in the Annex to the self-evaluation report. We specifically point at the reports from the Curriculum Development Committee (VK1 and VK2) which have largely determined the current structure of the NTNU engineering education programmes (1993) and their non-technology components (2003).
1. Engineering Education at NTNU

1.1 Background – from NTH to NTNU

The engineering education and research at the Norwegian University of Science and Technology (NTNU) has its roots in the tradition of the Norwegian Institute of Technology (NTH). The institute was established in 1910 and located in Trondheim to serve national needs, - at the same time operating on an international arena.

The engineering education at NTH-NTNU has from the start and still is maintained as one education. The programmes of study have evolved according to the needs of the society and the international developments in science and engineering. Over the years, the executive committee for the engineering education has, with support from the professors and departments/faculties, coordinated and maintained a common programme structure for the engineering education. The students have a common base in natural sciences offered by the department responsible for the discipline. The programme structure has been flexible enough to allow new programmes to merge and new specializations to develop.

From the outset, NTH offered architecture, mining, construction, electro-technical subjects, chemistry and mechanical engineering. The programmes could not be too narrow in scope, but had to give a good basis for whatever challenge the new engineers were to take on in Norwegian society. The students and researchers from NTH played key roles in the development of the marine industry and the new industries based on the expanding hydro-electric power supply.

In the post-war period, the engineering education and research activity expanded rapidly to foster industrial development and growth. New industrial opportunities emerged and NTH-NTNU have been able to adapt rapidly to furnish industry with candidates and expertise in petroleum technology (1970s) and ICT (1980s) to take just two examples. A new programme of study in nanotechnology is currently implemented.

In the 1990s increased emphasis was placed on quality assurance. NTH was a pioneer in Norway by introducing systematic student evaluations and pedagogical requirements for academic positions. The students have since been active members of the committees in charge of the programmes of study and the overall coordination of the engineering education. The Curriculum Development Committee (VK) specifically tried to follow-up the advice of students and industry in their proposal for a revised structure in the engineering education.

There has always been an element of non-technology subjects in the engineering education and in the 1990s a new programme in industrial economics and technology management was introduced. In the mid-1990s, the Curriculum Development Committee (VK) recommended to expand the educational programme from 4 ½ years to a 5 year MSc programme to strengthen the non-technology component, make it possible to introduce technology earlier in the programme and open up for more specialization in the latter part of the programme. The new programme structure was implemented after NTH became part of NTNU in 1996.
**NTNU 2020 – internationally outstanding**

NTNU is a fully integrated university\(^1\) with a broad academic scope covering most classical university disciplines albeit with a main focus on technology and the natural sciences. Of the 20,000 students at NTNU, 32% are registered students in technology. The broad academic scope of NTNU offers new opportunities for interdisciplinary research and education. Wider access to non-technology competence in the engineering education from within the university is one of the advantages of the NTNU structure.

Even though some university colleges in Norway have obtained university status\(^2\) and may offer graduate engineering education, NTNU maintains its nationally leading position educating almost 80% of the MSc engineers in Norway.

The strong position of NTNU in research can largely be attributed to the close collaboration between NTNU and SINTEF.\(^3\) The two institutions are the dominant technology institutions in Norway, enjoying also a high reputation internationally in many research areas. The two institutions work closely in many research areas to the benefit of industry and international research partners. By joining forces, it is has been possible to develop internationally advanced laboratories which otherwise would not have been possible for the individual institution. Many SINTEF researchers hold adjunct positions at NTNU and are a valuable additional teaching resource in the engineering education.

Research and higher education are global activities that can be characterized by increased competition for human and material resources. In the NTNU strategy “NTNU 2020 – Internationally Outstanding” (see Annex I), it is therefore emphasized that NTNU has to be continuously engaged in measures to enhance the quality of all activities. Our vision is that by 2020 NTNU is to be internationally recognized among the leading technological and scientific universities in Europe. The evaluation of the engineering education is to contribute to this vision.

### 1.2 Key figures – Faculties with Natural Sciences and Technology

**Engineering students and candidates**

There is fierce competition nationally for the graduates from upper secondary school with a natural science background. However, NTNU is for most engineering students the number one choice and is able to attract rather good students. In engineering, there are 9-12 applicants per student place. Most students complete their education on time - largely attributed to a

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\(^1\) The Norwegian University of Science and Technology (NTNU) was established in 1996 replacing the weak umbrella organization, the University of Trondheim (1968), the Norwegian Institute of Technology (1910), the College of Arts and Science (1922), the Faculty of Medicine (1975), the Music Conservatory (1968), Trondheim Academy of Fine Art (1979) and the Museum of Natural History and Archaeology (1767) were merged into a fully integrated new university structure.

\(^2\) Norwegian University of Life Sciences (2005), University of Stavanger (2005) and University of Agder (2007).

\(^3\) SINTEF was established by NTH in 1950 to handle applied research activities. The foundation soon grew to become one of Europe’s largest independent research institutes with about 1700 employees today and operations all over the world. The collaboration includes strategic cooperation between the institutions as well as joint applications for larger R&D projects with national and international funding. In many areas the two institutions are closely interlinked in terms of personnel, infrastructure and research activities. Both institutions also aim to stimulate innovation and industrial development.
well-structured programme and the possibility to repeat the final course examination before the next semester. Drop-out rates, however, have increased in later years as will be seen from the self-evaluation.

NTNU is one of the larger engineering education institutions in Europe with 1400 new students admitted and nearly 1200 MSc graduates in 2006. The students are admitted to the 16 programmes of study which are administrated by:

- Faculty of Information Technology, Mathematics and Electrical Engineering (IME)
- Faculty of Engineering Science and Technology (IVT)
- Faculty of Natural Sciences and Technology (NT)
- Faculty of Social Sciences and Technology Management (SVT), Department of Industrial Economics and Technology Management (IØT).

Table 1: Engineering students and candidates at the NTNU Faculties with natural sciences and engineering. Source: DBH 2006

<table>
<thead>
<tr>
<th></th>
<th>IME</th>
<th>IVT</th>
<th>NT</th>
<th>IØT</th>
<th>Technology</th>
<th>NTNU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registered stud.</td>
<td>1888</td>
<td>2696</td>
<td>1072</td>
<td>597</td>
<td>6253</td>
<td>19777</td>
</tr>
<tr>
<td>60 ECTS prod.</td>
<td>1334</td>
<td>1746</td>
<td>659</td>
<td>444</td>
<td>4182</td>
<td>13389</td>
</tr>
<tr>
<td>Applicants</td>
<td>3596</td>
<td>7478</td>
<td>2433</td>
<td>1495</td>
<td>15002</td>
<td>58361</td>
</tr>
<tr>
<td>Admitted stud.</td>
<td>376</td>
<td>688</td>
<td>243</td>
<td>123</td>
<td>1430</td>
<td>5702</td>
</tr>
<tr>
<td>MSc candidates</td>
<td>504</td>
<td>418</td>
<td>116</td>
<td>136</td>
<td>1174</td>
<td>2962</td>
</tr>
<tr>
<td>PhD candidates</td>
<td>37</td>
<td>52</td>
<td>38</td>
<td>3</td>
<td>130</td>
<td>244</td>
</tr>
</tbody>
</table>

Composition of academic staff

The engineering education has a very intensive teaching and learning programme compared with classical university studies with 20 hours a week of scheduled lectures and exercises. This is demanding for the academic staff responsible for the quality of the programmes of study. The professors give lectures and have the overall responsibility, while research fellows and assistant lecturers take care of most of the exercises. The number of professors per student at the faculties with natural sciences and engineering varies between 14 and 19 students per professor.

Table 2: Composition of academic staff at the NTNU Faculties with natural sciences and engineering (number of man years in selected positions). Source: DBH 2006

<table>
<thead>
<tr>
<th></th>
<th>IME</th>
<th>IVT</th>
<th>NT</th>
<th>IØT</th>
<th>Main profile</th>
<th>NTNU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professors</td>
<td>101</td>
<td>127</td>
<td>101</td>
<td>10</td>
<td>339</td>
<td>551</td>
</tr>
<tr>
<td>Associate Professors</td>
<td>60</td>
<td>46</td>
<td>41</td>
<td>25</td>
<td>172</td>
<td>409</td>
</tr>
<tr>
<td>Reg.stud/Professor</td>
<td>19</td>
<td>16</td>
<td>14</td>
<td>17</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>Adjunct Professors</td>
<td>4</td>
<td>11</td>
<td>7</td>
<td>2</td>
<td>24</td>
<td>47</td>
</tr>
<tr>
<td>Research Fellows</td>
<td>184</td>
<td>164</td>
<td>205</td>
<td>21</td>
<td>574</td>
<td>894</td>
</tr>
</tbody>
</table>

Operating income and expenses

NTNU obtains its basic funding for research, education and third stream activities from the Ministry of Education and Research. Part of the public funding is incentive-based related to candidate production and research output (doctoral candidates, scientific publications and

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4 It is difficult to distinguish between professors in engineering and professors in natural sciences. The student/staff ratio thus includes all engineering and science students at these faculties and the professors/associate professors responsible for the quality of these studies.
external funding from the EU and the Research Council of Norway). NTNU has chosen to use a similar model internally for the budget distribution between the faculties. Education is considered a public responsibility. External funding is primarily related to research activities. External funding represents 23% at IME, 33% at IVT and 36% at NT of the operating income at these faculties.

Most faculties perceive that they have a very limited freedom of manoeuvre. Labour costs make up 60-70% of the total operating expenses.

Table 3: Operating income and expenses of the NTNU Faculties with natural science and engineering. Source: DBH 2006

<table>
<thead>
<tr>
<th></th>
<th>IME</th>
<th>IVT</th>
<th>NT</th>
<th>IØT</th>
<th>Main profile</th>
<th>NTNU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ministry of Education and Research, other Ministries</td>
<td>335 521</td>
<td>357 227</td>
<td>356 083</td>
<td>48 593</td>
<td>1 097 424</td>
<td>2 687 844</td>
</tr>
<tr>
<td>External funding</td>
<td>101 241</td>
<td>179 592</td>
<td>202 102</td>
<td>18 358</td>
<td>501 293</td>
<td>917 438</td>
</tr>
<tr>
<td>Other income</td>
<td>2 082</td>
<td>13 579</td>
<td>8 571</td>
<td>0</td>
<td>242 32</td>
<td>156 797</td>
</tr>
<tr>
<td>Operating income</td>
<td>438 844</td>
<td>550 398</td>
<td>566 756</td>
<td>66 951</td>
<td>1 555 998</td>
<td>3 762 079</td>
</tr>
<tr>
<td>Wage costs</td>
<td>311 891</td>
<td>324 885</td>
<td>335 654</td>
<td>41 844</td>
<td>1 014 274</td>
<td>2 272 963</td>
</tr>
<tr>
<td>Investments</td>
<td>9 977</td>
<td>6 635</td>
<td>36 973</td>
<td>977</td>
<td>54 562</td>
<td>292 041</td>
</tr>
<tr>
<td>Other operating expenses</td>
<td>106 416</td>
<td>203 532</td>
<td>219 416</td>
<td>20 386</td>
<td>549 750</td>
<td>1 312 139</td>
</tr>
<tr>
<td>Operating expenses</td>
<td>428 284</td>
<td>535 052</td>
<td>592 043</td>
<td>63 207</td>
<td>1 555 379</td>
<td>3 877 143</td>
</tr>
</tbody>
</table>

1.3 MSc Engineering Education at NTNU

1.3.1 Learning outcomes

The VK2 Committee formulated the overall learning outcomes for the MSc Degree in Engineering as:

The education is to provide students with:

Knowledge
- Sound scientific basic knowledge that will provide a platform for the understanding and application of engineering methods, adaptive versatility to innovation, development of scientific and technological knowledge and changing economic and environmental conditions and priorities
- Broad scientific knowledge in engineering
- Research-based specialization in specific areas

Skills
- Training in defining, analysing and modelling complex engineering challenges
- Training in creating a synthesis of comprehensive solutions that may involve several technological and non-technological subjects
- Training in creative work and innovative activities
- Training in assessing calculations and results
- Training in teamwork and communication
- Training in leadership and the motivation of colleagues
Attitudes

• *Stimulation towards being innovative and creating economic and environmental viable activities*
• *Entrepreneurial ability that can translate research results into commercial opportunities*
• *Ethical values and basic attitudes that enhance the understanding of engineering knowledge and activities as an influential and integral part of a comprehensive social and environmental fabric*

### 1.3.2 Programme structure

The current principles for the engineering education at NTNU are described in the referred document *Engineering Education in the 21st Century* (1993, Annex II). The principles were built on the experience from the previous 80 years of engineering education at NTH and a broad questionnaire survey in 1993 and 2003. This was sent to engineers, industrial companies and the public sector in Norway and was a benchmarking to acknowledged higher engineering educations in Europe and in the US. The main change which was recommended by the Curriculum Committee (1993) was an increase in the duration of study from 4.5 to 5 years. The main argument for the expansion was the need for:

- more and new “non-technological” subjects in the curriculum (non-tech courses),
- standardization of size of the courses (7.5 ECTS or a multiple of 7.5 ECTS), and
- a curriculum structure based on the “fade in – fade out” principle; This means that the load of mathematics, basic science and (generic) engineering courses, that dominates the first 2-3 years of the 5 year curriculum, is gradually faded out, and so opens more space for the core engineering courses in the individual engineering programmes.

**Figure 1: The basic structure of the engineering education at NTNU**

<table>
<thead>
<tr>
<th>Sem</th>
<th>7.5 ECTS</th>
<th>7.5 ECTS</th>
<th>7.5 ECTS</th>
<th>7.5 ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>MASTER’S THESIS (20 weeks)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>NON-TECH 4 (Elective)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Interdisciplinary Teamwork (course)</td>
<td>ENG –other programmes</td>
<td>ENG</td>
<td>Elective course (Bas/Eng/Non-tech)</td>
</tr>
<tr>
<td>7</td>
<td>TECHBAS 5</td>
<td>NON-TECH 3 (Perspective course)</td>
<td>ENG</td>
<td>ENG</td>
</tr>
<tr>
<td>6</td>
<td>MATHNAT 4</td>
<td>ENG</td>
<td>ENG</td>
<td>ENG</td>
</tr>
<tr>
<td>5</td>
<td>STATISTICS</td>
<td>NON-TECH 2</td>
<td>ENG</td>
<td>ENG</td>
</tr>
<tr>
<td>4</td>
<td>MATH 4</td>
<td>MATHNAT 3</td>
<td>TECHBAS 4</td>
<td>ENG</td>
</tr>
<tr>
<td>3</td>
<td>MATH 3</td>
<td>MATHNAT 2</td>
<td>TECHBAS 3</td>
<td>ENG</td>
</tr>
<tr>
<td>2</td>
<td>MATH 2</td>
<td>MATHNAT 1</td>
<td>TECHBAS 2</td>
<td>ENG</td>
</tr>
<tr>
<td>1</td>
<td>MATH 1</td>
<td>NON-TECH 1: Ex.phil</td>
<td>TECHBAS 1: ICT basis course</td>
<td>ENG</td>
</tr>
</tbody>
</table>

**Legend:**

- MATH = mathematics course
- MATHNAT = natural science course
- TECHBAS = technological basic course
- ENG = engineering course
- NON-TECH = non-technological course
- Hatching indicates mandatory courses
Currently, the overall structure of the curriculum consists of mathematics and statistics (totally 37.5 ECTS), natural science courses (totally 30 ECTS), engineering science courses (30 – 45 ECTS), non-tech courses (totally ECTS), and the Interdisciplinary Teamwork course (7.5 ECTS). The fifth and final year consists of one of the non-tech courses, a project work (15 ECTS), one course that is related to the project work, and the more independent MSc thesis (30 ECTS). These topics are organized in a way that the more generic topics included in certain groups of the courses are taught early in the programmes thus making a foundation for several of the other courses. This is illustrated in Figure 1.

All engineering programmes start with a common portfolio of basic introductory courses in mathematics, physics, computer science, a course in Philosophy of Science and Ethics and basic engineering subjects depending on the specific engineering programme. When the students have established a sufficient basis in these subjects, new, more advanced courses in engineering, natural science are faded in together with 3 more courses in “non-technical subjects”.

In the 8th semester, called the multidisciplinary semester, students have to select an engineering course from other engineering programmes (ENG-other programmes) and start on their engineering specialization (“main engineering profile”) by selecting two courses from a limited list of courses, engineering and/or an elective BAS/ ENG/ NONTECH course. In this semester the students are also required to take part in a project course called Interdisciplinary Teamwork (EiT) where together with master’s students from other programme of study at NTNU they are expected to work as a team to contribute constructively and creatively in mastering a multidisciplinary challenge.

In the 9th semester the students are to do their main specialization: the in-depth project, combined with one or two complementary courses to give a broader scientific basis for the research in preparation for the project work, all together 22.5 credits (3/4 of a semester). In the 10th semester the students are to do their research-based master’s thesis work, 30 credits (one semester), within their area of specialization.

1.3.3 Portfolio of programmes of study

The degree Master of Science in Engineering at NTNU is an integrated 5-year master’s programme currently within 16 different areas of technology. The various programmes of study address societal competence requirements in sectors as indicated by their names (e.g. Civil and Environmental Engineering), or generic technological competences needed in many sectors (e.g. Industrial Economics). In addition to enrolment from upper secondary school to the programmes of 5 years nominal duration, most programmes also recruit some students to corresponding 2-year MSc programmes, which are similar to the 2 last years of the 5 year programmes, based on a completed Bachelor of Engineering. In 2007, 1500 students were enrolled in the regular MSc Engineering programmes at NTNU (see Table 4).

NTNU has in recent years also established a portfolio of international 2-year MSc in Engineering programmes (see Table 5). The programmes (with the exception of three older programmes) are in principle build on the same structure as the last 2 years in the ordinary 5-year programmes of study, but the courses are taught in English, and are in general focused within a more narrow and specific research areas.
The Executive Committee for the Engineering Education (FUS) has established procedures to avoid parallel teaching in closely related topics within the international MSc programmes and those for the MSc Engineering degree.

Table 4: Programmes of study in engineering and number of admitted students 2007

<table>
<thead>
<tr>
<th>Name of programmes of study, 5 year</th>
<th>Faculty</th>
<th>Students/year (07)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master of Science in Applied Physics and Mathematics</td>
<td>NT</td>
<td>115</td>
</tr>
<tr>
<td>Master of Science in Chemical Engineering and Biotechnology</td>
<td>NT</td>
<td>95</td>
</tr>
<tr>
<td>Master of Science in Materials Science and Engineering</td>
<td>NT</td>
<td>30</td>
</tr>
<tr>
<td>Master of Science in Nanotechnology</td>
<td>IME</td>
<td>30</td>
</tr>
<tr>
<td>Master of Science in Communication Technology</td>
<td>IME</td>
<td>50</td>
</tr>
<tr>
<td>Master of Science in Computer Science</td>
<td>IME</td>
<td>110</td>
</tr>
<tr>
<td>Master of Science in Electronics</td>
<td>IME</td>
<td>90</td>
</tr>
<tr>
<td>Master of Science in Energy and Environmental Engineering</td>
<td>IME</td>
<td>120</td>
</tr>
<tr>
<td>Master of Science in Engineering Cybernetics</td>
<td>IME</td>
<td>110</td>
</tr>
<tr>
<td>Master of Science in Civil and Environmental Engineering</td>
<td>IVT</td>
<td>210</td>
</tr>
<tr>
<td>Master of Science in Earth Sciences and Petroleum Engineering*</td>
<td>IVT</td>
<td>105</td>
</tr>
<tr>
<td>Master of Science in Engineering and ICT</td>
<td>IVT</td>
<td>50</td>
</tr>
<tr>
<td>Master of Science in Marine Technology</td>
<td>IVT</td>
<td>100</td>
</tr>
<tr>
<td>Master of Science in Product Design Engineering</td>
<td>IVT</td>
<td>25</td>
</tr>
<tr>
<td>Master of Science in Product Design and Manufacturing</td>
<td>IVT</td>
<td>140</td>
</tr>
<tr>
<td>Master of Science in Industrial Economics and Techn. Management</td>
<td>SVT/IØT</td>
<td>120</td>
</tr>
<tr>
<td>Total number of students admitted per year (2007)</td>
<td></td>
<td>1500</td>
</tr>
</tbody>
</table>

* Divided in two programmes from 2008/2009

Table 5: International MSc programmes in engineering at NTNU

<table>
<thead>
<tr>
<th>Name of international programmes of study, 2 year</th>
<th>Faculty</th>
<th>Students/year (07)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSc in Light Metals Production</td>
<td>NT</td>
<td>5</td>
</tr>
<tr>
<td>MSc in Medical Technology</td>
<td>NT</td>
<td>2</td>
</tr>
<tr>
<td>MSc in Information Systems</td>
<td>IME</td>
<td>4</td>
</tr>
<tr>
<td>MSc in Electric Power Engineering</td>
<td>IME</td>
<td>18</td>
</tr>
<tr>
<td>Master's Programme in Security and Mobile Computing (Joint degree)</td>
<td>IME</td>
<td>17</td>
</tr>
<tr>
<td>Master of Science in Coastal and Marine Civil Engineering</td>
<td>IVT</td>
<td>2</td>
</tr>
<tr>
<td>Master's Programme in Coastal and Marine Engineering and Management (Erasmus Mundus)</td>
<td>IVT</td>
<td>18</td>
</tr>
<tr>
<td>MSc in Petroleum Engineering</td>
<td>IVT</td>
<td>16</td>
</tr>
<tr>
<td>MSc in Petroleum Geosciences</td>
<td>IVT</td>
<td>8</td>
</tr>
<tr>
<td>MSc in Geotechnics and Geohazards</td>
<td>IVT</td>
<td>8</td>
</tr>
<tr>
<td>MSc in Hydropower Development</td>
<td>IVT</td>
<td>10</td>
</tr>
<tr>
<td>MSc in Industrial Ecology</td>
<td>IVT</td>
<td>9</td>
</tr>
<tr>
<td>MSc in Marine Technology</td>
<td>IVT</td>
<td>8</td>
</tr>
<tr>
<td>MSc in Reliability, Availability, Maintainability and Safety</td>
<td>IVT</td>
<td>3</td>
</tr>
<tr>
<td>Master of Science in Project Management</td>
<td>IVT</td>
<td>7</td>
</tr>
<tr>
<td>Sum of admitted students International Programmes in 2007</td>
<td></td>
<td>135</td>
</tr>
</tbody>
</table>
1.4 Quality assurance system at NTNU

In accordance with the Bologna process, and as an important part of the implementation of the Quality Reform in Higher Education in Norway 2003 (Quality Reform 2003), all Norwegian higher education institutions have to implement a quality assurance system for their educational programmes. The Norwegian national system is based on audits, where the Norwegian Quality Assurance Agency (NOKUT) is responsible for the accreditation of higher education institutions and their programmes and courses. It also evaluates the internal quality assurance schemes at these institutions to see if they fulfil their stated criteria. This approach gives the institutions freedom to define quality assurance processes that encompass the educations offered, and that provide feedback needed to enhance quality as defined by the institution.

At NTNU the principles for quality assurance system state that the primary objective of the quality assurance is not control, but improvement, (see the document on the principles for quality assurance at NTNU, dated November 2003, Annex III). The system defines processes to be performed as part of the quality improvement process, with clearly stated responsibilities for the different roles involved, ranging from the students to the Rector, Figure 2.

Figure 2: Different roles in the Quality Assurance Support System at NTNU

As the process of enhancing quality requires a functional feedback loop, every time a programme of study is completed or a course is taught, it is regarded as an independent project with four phases: Planning, implementation, assessment of the achievement of objectives and quality, and improvement/adjustment, Figure 3.
The NTNU quality support system (KVASS) is built upon these principles and activities. In the graphical interface at the webpage, all processes are represented graphically in flowcharts indicating the role responsible for each activity. For each activity the system provides suggestions, examples, checklists, templates, links to regulations and support units, as well as especially developed applications. Applications include a tool for developing student surveys with a set of predefined questions and responses to choose from, a tool for generating relevant statistics for evaluating the quality of courses and a tool for tracking the execution of core quality improvement activities in each course, see Figure 4.

Figure 3: Education regarded as a project with feedback loops. The main entry point to KVASS. Source: http://www.ntnu.no/studies/educationquality2

Figure 4: Annual cycle: Scheduling of important duties during the year
1.4.1 Learning methods and examination systems

Within the Master of Science in Engineering at NTNU, there is emphasis on learning methods, examination in and the evaluation of each course. There are given separate regulations for the assessment of courses (see Annex IV “Assessment regulations and the use of examiners in MSc engineering education at NTNU”). The Curriculum Development Committee gave much attention to learning methods in their first report (VK1:1993). The Quality Reform 2003 gives further attention to learning methods as well as forms of assessment, for that purpose to enhance learning quality, including stronger focus on the learning process and a closer follow-up of the student. As a consequence of the Quality Reform and the intention to have a closer follow-up of the student’s learning process, the Norwegian University Act was revised and now gives the teacher the opportunity to carry out examinations in each individual course during the whole semester without using external examiners.

Throughout the whole history of engineering education at NTH/NTNU there has been given considerable focus on applied engineering, with different methods of problem/project-based learning (PBL), broad use of mandatory calculation and laboratory exercises, combined with projects based on relevant cases from industry. NTH/NTNU, often in close collaboration with SINTEF, and with substantial support from industry, has build up several modern, well-equipped laboratories which are widely used in research as well as in teaching. Within each course of nominal workload 7.5 ECTS, there are typically 2 – 4 hours lessons per week (14 weeks per semester), 2 – 4 hours calculation exercises, laboratory work or project work, and with time for self-studies in-between. Exercises and self-studies are often based on teamwork with teams of typically 4 – 6 students. In some courses the students are to give oral presentations as a part of the exercises or examination. 1 ECTS corresponds to 30 hours of total work.

Depending on the nature of the subject and the judgment of the teachers, different forms of assessment are used in evaluating the students' learning outcome. Typical forms of assessment are: assessment based on only a written project work; only a final examination (written or oral), portfolio assessment or combinations of midterm examination(s) and a final examination where each grading are weighted, all-together 100 %. The grading Passed/Not passed is used in a few courses. More details regarding form of assessment and the use of examiners are described in the “Assessment regulations and the use of examiners in MSc engineering education at NTNU” (Annex IV).

1.4.2 Grading System at NTNU - a short description

As a part of the Quality Reform in Norway, a six-letter A-F grading system was introduced. In this system, A is the highest, and E is lowest passing grade. Grade F is a fail. In addition to the qualitative description in the regulations at NTNU, more specific description of the various grades within the MSc in Engineering at NTNU is given in the guidelines for this degree. Details of the practical application of the letter-based grading system in Norway are additionally provided by the Ministry. According to this, it is expected that the national distributions of the grades of large population are so close to the European ECTS standard, that a separate translation to ECTS grades is not needed.
1.4.3 Student advisory service
A well-functioning student advisory service is an important motivating factor as well as preventive effort to help student’s well-being and for achieving good results in their studies. During the last two years, a project has been established to define roles, responsibilities and qualifications for student advisers. There are student advisers at the faculties for each programme of study. At NTNU-level the Student and Academic Division has special advisers giving assistance concerning recruiting of students, general study and welfare questions, international exchange issues and guidance for students with disabilities and special needs. On average there is one adviser (not all full-time) per 100 students.

1.4.4 Government incentives to stimulate credit production
The student financing system from Norwegian State Educational Loan Fund (“Lånekassen”) is an important factor influencing learning quality. The student gets a part of the loan converted to a scholarship according to how many credits they achieve per semester. On the other hand, the Government assigns a great part of the university’s budget according to the production of credits by its students.

Generally speaking all Norwegian higher education institutions are not allowed to charge a tuition fee from their students, but the students have to pay for books and other individual learning equipment used in the studies.

1.5 Organization and Management
We refer to the mandate for the Executive Committee for Engineering Education at NTNU (FUS) (Annex V) and the Executive Committee for Education at NTNU (Education Committee) (Annex V). FUS is an inter-faculty executive committee with the mandate to:
- oversee, develop and execute common solutions for the MSc in Engineering Education at NTNU and
- promote proposals on the principle structure and curriculum to the Education Committee (which in fundamental and overall questions functions as the board of FUS).

FUS meets 8 to 10 times per semester, and is managed by the Dean of Engineering Education who chairs the meetings and has delegations from FUS to make decisions regarding some current tasks. Besides the Dean of Engineering Education, FUS consists of the current Vice-Deans for education from the four Faculties having master’s programmes in engineering, and two student representatives. The secretary is organized in the staff of the Director of the Student and Academic Division, who reports to the Pro-Rector for Education and Quality of Learning.

The Dean represents engineering education at NTNU on behalf of the Rector, and is a representative in the Education Committee (without formal right to vote). The Dean also is one of NTNU’s four members of The National Committee for Technological Education (NRT), which is one of the strategic units of The Norwegian Association of Higher Education.
Institutions (UHR).\textsuperscript{5} The Dean of Engineering Education at NTNU is the current elected chair of the National Committee for Technological Education.

Every programme of study has a Programme Council, appointed by the Dean at the Faculty which is administratively responsible for the programme (decided by the NTNU Board). The Programme Council consists of representatives from the academic staff/Department which gives substantial teaching to the programme, students, external representatives from industry and a programme secretary at the Faculty. The Programme Council is responsible for the annual:
- reception of the new students,
- planning, implementation and evaluation of the teaching of the programme and
- review and suggestion of revisions in the programme of study (incl. implementation of the results of the self-evaluation undertaken in 2007).
There are guidelines for the Programme Councils giving more specific descriptions of the tasks for the committee.

Some of the programmes also have an “Industry Ring” with representatives from industry to:
- give support to the programme of study on recruitment of students, as well as
- make professional recommendations to the content of the programme of study.

1.5.1 Student democracy and student welfare
The students play a constructive role in the various committees and councils at NTNU. There are in general two student representatives on each committee or council, as well as on the University Board. The student democracy is in general considered to be a very important contribution to the student’s well-being and the attractiveness of NTNU as a well-functioning institution of higher education.

The Student Parliament of NTNU is the highest governing body of the student democracy at the university. 25 students are elected for one year and represent all students at the university. These students are independent from the Student Councils. The Student Councils at the Faculties are run by representatives elected by the different engineering programmes. On each level, from the class to Faculty, there are two student representatives. The Student Council is led by two student representatives. In matters which are important for all engineering programmes, NTNU has its own Student Council for Engineering.

The Student Welfare Organization (SiT) provides many services to the students such as health services, student housing and child care. On campus SiT has bookstores and restaurants. The welfare organization also operates sports centres on the two main NTNU campuses. All the students have to be members of SiT to be enrolled as students at NTNU (regulated by Norwegian legislation). Many of the positions in the Board of the Student Welfare Organization and representative committees are held by students.

\textsuperscript{5} The Norwegian Association of Higher Education Institutions (UHR) is a cooperative body for the universities and university colleges in Norway. It facilitates cooperation and coordination among Norwegian HEI and advocates shared positions on central issues concerning higher education and research policy towards the Norwegian government, parliament and society in general.
1.5.2 Student social life

Trondheim is known for its rich student life owing to a multitude of activities organized by the students themselves. The NTNU sports association has 8000 members and offers a wide range of sports or activities.

Trondheim is also known for the student festival UKA. It has been organized by the engineering students since 1917. Today students from all parts of NTNU are engaged. The student revue is the main attraction, supplemented with numerous concerts and parties for current students, alumni and local residents. The festival is the main source of income for the maintenance of the Students’ Association building (Studentersamfundet), which is a landmark in Trondheim. The Students’ Association is run by students on a voluntary basis, involving thousands of volunteers for the student festivals UKA and the “newcomer” ISFiT (the International Student Festival).

Engineering education in Trondheim is, furthermore, known for the student fraternities (Linjeforeninger). They play an important role during the introductory weeks, but also arrange all sorts of social and professional activities during the entire academic year.

Trondheim is truly a student town. During the academic year one in five citizens in Trondheim is a student. The city and the university cooperate to develop Trondheim as an attractive student town and facilitate contact between students and regional working life. The entrepreneurial talent of the engineering students is an asset which is highly valued by prospective employers. The students themselves are actively seeking contact organizing business fairs and industry visits. NTNU operates an on campus incubator for students who want to start their own business and the student organization START NTNU promotes innovation and entrepreneurship among their fellow students.

2. Presentation of main issues in the evaluation

2.1 Relevance of the Engineering Programme to the needs of the society

The societal relevance of the MSc Engineering Programme can be viewed from three different angles:

1. Does the degree have a portfolio of programmes of study and specializations where the content and quality satisfy the need for society in the future as we see it now?
2. Does the degree prepare the students for an uncertain future that is inherently difficult to foresee when it comes to new knowledge, changing economic ramifications and opportunities for engineering activities, where there are new societal and political priorities concerning viable economic and environmental development?
3. What should be the guiding principles for determining the number of MSc engineers graduating from NTNU from the different programmes of study?

Due to the complexity of the market situation NTNU has unfortunately not been able to establish sufficient statistics or data that provide a good analysis of the needs for engineers in society either in the short or long terms. In 2003, the Curriculum Committee (VK2:2003) carried out a survey among a large and fairly representative sample of Norwegian MSc
engineers. This survey asked different questions related to the relevance of different topics in the MSc Engineering degree at NTH/NTNU (VK2 Appendix 2, questions 9-18). The respondents also gave information on their current employment, function and role in their organization (VK2 Appendix 2, questions 1-8). But although these data give a fairly comprehensive picture on employment and the professional careers of MSc engineers in Norwegian society, it is a static snapshot with limited bearing for curriculum planning where societal relevance usually should be high on the agenda.

The departments at NTNU that are involved in planning and teaching the different programmes of study have extensive industrial contacts, and external representatives from industry and the public sector are often involved in discussions and evaluations of a programme of study. Most of the programme councils have external members. In addition, the portfolio of research activities reflects external financing and industrial demand. These external relations will to a certain degree help to keep the development of teaching and research on track with the needs and priorities of society as far as we see the future needs now.

However, it is more important how the MSc Engineering degree prepares the students for changing future needs and ramifications of engineering possibilities and challenges, - changes that are difficult to perceive today with reasonable precision. These concerns were part of the Curriculum Development Committee’s (VK1 in 1993) discussion and recommendation for reforming the curriculum of the MSc Engineering degree.

VK1 opted for a curriculum structure that was intended to secure educational flexibility by building the engineering specialization in different programmes of study on a fundament of mathematics, basic science, information technology and (generic) engineering topics. This way of thinking was confirmed by the Curriculum Committee in 2003 (VK2) which completed a more specific analysis and recommendations concerning the role, structure and content of “non-technological” topics in the MSc Engineering degree.

The curriculum structure recommended by VK1 has the following characteristics:

- A five-year integrated study with heavy emphasis on mathematics, basic science and information technology and basic (generic) engineering topics in the 2 -3 first years of study.
- A widening string of engineering courses specific for individual programmes of study and starting in the first semester
- A string of 4 “non-technological” courses including a course in Philosophy of Science and Ethics
- The two last years of the study are dedicated to specialization but also includes a semester that opens for courses from other programmes of study and a mandatory team-building course (Interdisciplinary Teamwork).

The VK1 Committee’s intensions for giving strong priorities to mathematics and basic science in the first years of study were to build robust flexibility for changing future needs into the curriculum as follows:

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6 VK2 Appendix 2 is in Annex II to this report. The VK2 report is available in English translation, while the questions and the results of the survey are in Norwegian only.
• Give the engineering students a broad and versatile analytical platform for different tasks and challenges in their future role as MSc engineers and likewise give them a robust platform for lifelong learning.
• Give the students within the specific programmes of study a platform for specializing in a wide variety of topics at the end of their study depending on their interests and what they find relevant when they complete the MSc Engineering degree. This will to a certain degree give the student the possibility to decide on his/her direction of specialization relatively late in their study and enhance his/her competence profile to the perceived needs of society.
• Give a robust platform for the individual programme of study to gradually change the content and portfolio of specialization and even introduce new programmes without changing the basic template of courses in the 2 to 3 first years of the MSc Engineering degree.

The answers given in the VK2 survey may be interpreted as a strong confirmation of the importance of a sound platform of mathematics and basic science in the MSc Engineering degree. But of course, the VK1 Committee’s recommendations have built several compromises in when trying to strike a balance between competing aims. These conflicting choices are still with us. Besides, the (3+2) model of the Bologna process has added new challenges for a 5-year integrated MSc in Engineering – especially if the 3 first years of study are going to be a well rounded-off Bachelor in Engineering.

The main dilemmas inherent in the VK1 curriculum structure can be summarized as follows:
• How does the curriculum structure in the MSc Engineering degree at NTNU compare to well-regarded MSc degrees in Engineering at other universities in Europe when it comes to enhancing the possibility for fulfilling the core learning outcomes stated in Section 1.3.1?
• The content, composition and priority given to “non-technological” courses and Interdisciplinary Teamwork course have been a persistent topic of debate since the introduction of the VK1 curriculum structure. These important questions are far from resolved yet.
• The quality of the learning outcomes reached in the individual programmes of study are dependent on how far the learning activities in the programme can take advantage of the common foundation of mathematics and basic science in the MSc Engineering degree. Is this implicit intension in the VK1 curriculum structure realized?
• The VK1 curriculum structure implies that the students at the beginning of the MSc Engineering degree experience what many of them perceive as heavy theoretical teaching without grasping the use of it before they get to the third year of study. This represents a challenge for the motivation of the students for the first two or three years. To what degree does this represent a challenge to the coherence of the VK1 curriculum structure?
• The first years of the study set a threshold that is difficult to pass unless the students recruited are from among the best qualified candidates from upper secondary school. This sets narrow limits for how many students that can be recruited to the different programmes in MSc Engineering degree today. The output of MSc engineers from NTNU is in foreseeable future not limited by the demand in society, but by the possibility to recruit the most talented of the qualified candidates from upper secondary school. If one wishes to alleviate the last restriction, NTNU has to
implement a more active and systematic policy of recruiting students from abroad. How can that best be done?

- In the VK1 curriculum structure the learning outcomes in a programme of study are realized through a five-year integrated course plan. In this curriculum structure the first three years give the student the theoretical fundament for the specialization in the two last years. It is not meaningful to say that the first three years represents a well-rounded Bachelor in Engineering. Strictly speaking, such a well-rounded Bachelor in Engineering should be the learning outcomes for the first three years in the (3+2) Bologna model. There are different ways to circumvent this challenge, but the main question remains: what are the strengths and weaknesses of the VK1 curriculum structure for international student mobility within the future framework of the Bologna process?

2.1.1 Learning outcomes defined for each programme of study

An important part of the self evaluation has been to formulate learning outcomes for the engineering programmes. One challenge was to find a common model for formulating learning outcomes for the programmes since this has not done before. The next step was to redefine the earlier individual freely formulated learning outcomes in accordance with this model. We chose a model used at Delft University of Technology, the “QANU protocol” (Quality Assurance Netherlands Universities), which is based on the Dublin Descriptors, an European standard for description of learning outcomes.

The QANU protocol specifies the total learning outcomes in eight categories,

1. Broad and substantial knowledge of mathematics, physics and computer science. Capability to apply this knowledge at an advanced level to the programme of study disciplines.
2. Broad and profound scientific and technical knowledge of the programme of study disciplines, and skills to apply this knowledge effectively. In selected areas, the knowledge reaches the forefront of scientific or industrial research and development. The knowledge level makes a good basis for innovative contributions to the disciplines.
3. Thorough knowledge of practical methods and tools within the programme of study disciplines and skills to actively apply them for analysing, modelling, simulating, implementation and testing.
4. Ability and skills to independently solve complex problems in a systematic way
5. Ability to work in (multidisciplinary) teams, interacting effectively with specialists and taking initiatives where necessary.
6. Good communication skills in Norwegian and English
7. Ability to identify, assess and evaluate ethical and social impact of own work
8. Attitude and ability to independently maintain professional competence through life-long learning

Most of the Programme Councils found it very useful to do this “exercise”. In the next step they could judge the relevance of every course in the programme to which extent the course contributes to reach the learning outcomes. Some programmes evaluated the contribution of the intended learning outcome from each individual course to the overall programme learning outcome as well. This way of attacking the evaluation work led to a new way of thinking in more holistic terms about the relevance and quality of the programme. The experience also showed that the first four categories of learning outcomes to a large extent were individually different for each programme, while the last four categories were more common to all the programmes, and correspond well to the learning outcomes formulated in the VK2 report as the more generic learning outcomes for the engineering education at NTNU. In the next step their findings will be used, in combination with the recommendations from the evaluation
committee, and the more general conclusions from FUS and the Board of NTNU based on these recommendations, in a more systematic improvement process for each programme.

2.1.2 The self-evaluations of individual programme of study – highlights

The general opinion and judgement of the structure of the MSc Engineering programme at NTNU is that the principles and the practical experience during the implementation of the programme are very useful. Changes in the market needs are coming increasingly faster, and the requirement for a structure with a broad basis of mathematics, natural science and technology, and the flexibility to adapt the professional profile of the programme to specific and individual needs, are well undertaken by the curriculum model designed by VK1 and VK2. The figures for programme swop and drop-outs indicate some problems, and the experience from the Programme Councils show that there is potential for improvement. In the self-evaluation reports of the programmes of study some challenges are mentioned which must be met.

One challenge is the amount of different courses of various types which the programme wants to offer relative to the total framework of the given structure. The complexity of technological challenges within each professional area requires both broad scope as well as deep insight in many technological subjects. At the same time there is a requirement that each engineer is to have a broader perspective on their profession which represents an enhanced requirement for non-technological subjects. But one important question is how widely these subjects are to cover and to which extent the student is to select such subjects. This was a main issue in the VK2 report, and the recommendation from the committee was to be more restrictive and give more specific guidelines for choosing non-technological subjects according to the professional needs in the programme selected.

Another challenge mentioned in some self-evaluation reports is the rigidity of the structure regarding standardized size of each course and the given mandatory place for specific courses in the programme structure. There are well-motivated arguments behind these solutions, primary the option to exchange between alternative elective courses and the possibility to manage the timetable. Some programmes have special needs for different reasons (regarding progression, use of common courses with other programmes etc.), and FUS has been given the right to make exemptions in some cases.

A third challenge is the amount of assessment work relative to teaching. Even if NTNU uses three weeks for assessments every semester, the amount of selections and the possibility to combine some preferred courses is limited by the examination requirements. This problem is obviously connected to the size of the subjects and is the main reason why it is not necessary to make the course size smaller. But are there other possibilities to increase the amount of selection?

Overall, due to the needs for flexibility in the market it is important to undertake the possibility to individually adapt the professional engineering profile and specialization relatively late in the studies.
2.2 Recruitment and admission requirements

Up to the 1990s NTH (which merged into NTNU in 1996) nearly had a monopolistic position and a high reputation in the market for recruiting students to higher technological education in Norway. In general the quality of the incoming students was high. But due to the development of mass universities and a declining interest of learning mathematics and technology among youth in society, the competition to recruit the best students increased. In general NTNU has extended its requirements for admission from Upper Secondary School - academically oriented programmes so that it requires an upper level course in Mathematics and a next to upper level course in Physics for admission to the 5 year MSc Engineering programme. Additionally, the applicants have to compete for a limited number of places. There have normally been 2 to 6 applicants per admitted student to MSc Engineering, depending on the professional field of the programme, as their first choice of study among the national programmes of study. From 2006, NTNU is also are allowed to require a mark in Mathematics, upper level (“3MX”), of 4 or higher (where 6 is the highest mark). Already from 2004, NTNU decided to require grade C or better as an average grade from the Engineering University Colleges, corresponding to a Bachelor of Engineering degree, for the admission to the national 2-year MSc Engineering programmes.

Because of the limited number of qualified applicants in Norway, NTNU has given priority to recruitment activities to secure a sufficient amount of high quality applicants. In addition to informative brochures and web pages to present the engineering programmes, every year NTNU participates in several educational fairs at different places in Norway and visits a lot of Upper Secondary Schools. Figure 6 indicates that the recruitment to the 5-year MSc Engineering degree is nearly proportional to the size of the 19-23 year cohorts in the various regions of Norway. This clearly indicates that NTNU is a national university within higher technological education in Norway.

Table 6: Regional background of the NTNU engineering students admitted in 2007 and the regional distribution of the population (19-23 year olds). Source: Statistics Norway, 2007
NTNU also hosts the National Centre for Mathematics and the National Centre for Recruitment in Science and Technology (RENA TE). Both centres are established by the Government to improve motivation among youth for mathematics, natural science and technology in Norway. The centres cooperate with individual schools in trying out new learning methods and programmes, offer seminars for teachers and school management, and are also engaged in developing new course material, which portray technology in positive terms and the usefulness of mathematics to solve everyday problems.

In the last five years NTNU also has made efforts for recruiting a larger number of international students by offering 12 different international 2-year master’s programmes and a couple of Joint Degree/Erasmus Mundus programmes in engineering, and NTNU is in an alliance with KTH (Sweden), CTH (Sweden), DTU (Denmark) and TKK (Finland) named Nordic Five Tech (N5T), to promote internal student exchange and give support to recruitment of international students as well as promoting research and dissemination.

2.2.1 Equal opportunities in the MSc engineering education

In the Norwegian society, equal opportunities are emphasized in all walks of life. To increase the number of females in a traditionally male-dominated field such as technology is a particular challenge. NTNU is working long term to stimulate the recruitment of females among the students as well as our academic staff. After a long period with only 20 % females among the new technology students, the number has improved each year in the last five years reaching 30 % in 2007. Among the academic staff only 9.4 % of the professors are females, but the recruitment base is promising with 21 % females among the associate professors and 35 % among the research fellows. The figure below illustrates the challenge at the four units with engineering education.

*Figure 5: Percentage females among academic staff and registered students in natural sciences and technology at the relevant faculties/department individually and collectively.*
Source: DBH 2006

In our opinion, a better gender balance will increase the attractiveness of NTNU among potential applicants and contribute to a good working environment. Females may, furthermore, bring in new perspectives to the research agenda and learning process. To
achieve real equal opportunities, it is recognized that radical measures is called for, and in the action plan 2007-2010 it is stated that 50 % of all newly employed academic staff requiring a PhD should be female.

NTNU is nationally respected for the equal opportunities work among staff and students with an earmarked budget of NOK 3 million annually at NTNU level. The most well-known programme is called “Females and data” and offers female ICT students a professional meeting place during their studies. Reduced drop-out rates has been a positive effect. Similar network activities for females are introduced also in other technology programmes. NTNU also takes pre-emptive steps and female applicants to the engineering studies are invited to a one day programme at NTNU before the first semester starts to encourage them to actually choose NTNU. Of those who take part in that day, 95 % actually come to study engineering at NTNU. The five most popular programmes among female applicants during the past two years have been:

1. Industrial economics and technology management
2. Civil and environmental engineering
3. Chemical engineering and biotechnology
4. Earth sciences and petroleum engineering
5. Product design and manufacturing

2.2.2 Student accomplishment, programme swop and drop-outs

The increasing drop-out rate discovered in the statistic data for this evaluation work is a new challenge to engineering education at NTNU. While in earlier years we experienced a drop-out rate of 5 to 10 % and a completion rate of more than 90 % within the nominal duration of study, the new data indicates an increased drop-out rate, in particular for some specific programmes. On average 20 % of incoming students drop out, and 8 % swop to another engineering programme, while only 72 % complete their initially selected programme. To shed light on the problem, we have searched for information about:

- how many students complete their studies within their initially selected programme,
- how many students swop to another engineering programme during their studies, and
- how many students drop out before they graduate.

There may be many reasons for such relatively large swop and drop-out rates. There are some guidelines, limitations and instructions in the Examination Regulations at NTNU and the Supplementary Regulations for the MSc Degree in Engineering at NTNU (Annex IV), to assure progression and prevent drop-outs during the studies. Some reasons for drop-outs may be for the benefit of the individual student. But the indicators can and ought to be read as challenges to improvements regarding:

- recruiting information and activities, reception of incoming students,
- structure, content and progression in the engineering curriculum/programmes of study,
- pedagogical qualities, admittance to and quality of infrastructure,
- relevance of programmes to the needs of industry and society,
- the framework and regulations for studies at NTNU, and at last, but not least,
- the conditions for an attractive student environment.

All these factors are to be taken into account during the evaluation process.
Table 7: Drop-out analysis of the 5-year integrated MSc Engineering degree among students admitted in 2003 and 2004

<table>
<thead>
<tr>
<th></th>
<th>Students admitted 2003</th>
<th>Students admitted 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Per cent</td>
</tr>
<tr>
<td>Continue original MSc programme</td>
<td>904</td>
<td>61.2 %</td>
</tr>
<tr>
<td>Continue in another MSc programme</td>
<td>271</td>
<td>18.3 %</td>
</tr>
<tr>
<td>Dropped out of MSc programme</td>
<td>302</td>
<td>20.5 %</td>
</tr>
<tr>
<td>Total</td>
<td>1477</td>
<td>100.0 %</td>
</tr>
</tbody>
</table>

2.2.3 Motivation - introductory course “Teknostart”

The statistics indicate that most of the drop-outs occur during the first two years of the studies. In 2004 NTNU therefore established an introductory programme of two weeks duration, “Teknostart”, for the admitted students in the 5-year MSc Engineering programme to help them having a positive and motivating introduction to their engineering studies. Teknostart includes working in groups, introduction to mathematics and the intention to show the students the necessity of using mathematics in their prospective profession as engineers by solving a simple exercise within the profession of their selected programme. Teknostart has been evaluated every year, and is judged to be a success. But we still assume that there is potential to improve the structure and content of especially some of the engineering programmes to enhance the motivation for the studies.

2.3 Student mobility – nationally and internationally

The judgement of our engineering programmes has been that we have competitive programmes compared with our most relevant competitors. Up to 1990s NTH educated nearly 100 % of all graduates with an MSc degree in engineering in Norway. At present, NTNU educates about 80 % of the graduates with an MSc degree in engineering in Norway. Some of the other universities and university colleges in Norway are now accredited to educate MSc Engineering students.

NTNU has established parallel 2-year MSc Engineering to the integrated 5-year MSc Engineering programmes to admit candidates with a bachelor of engineering from a university college to take an MSc Engineering degree at NTNU. In 2007 NTNU admitted 140 candidates to these programmes of study. On the other hand very few students from NTNU apply for the 2-year master’s programme in engineering education at a university college, mainly due to the integrated 5-year programmes at NTNU. This is despite the fact that NTNU offers its engineering students a document which confirms that the qualifications after the first 3 years at NTNU are sufficient for admittance to a 2-year master’s programme.

Regarding international student mobility, NTNU has actively participated in the European cooperation associations within Higher Engineering Education (SEFI, CESAEER) since 1990, and much of the conditions for the engineering programme development over the last 10-15 years have been based on experience from international guidelines and the Bologna process. Historically the Norwegian model for engineering education is based on the German model, like most Scandinavian engineering education. International exchange of student and the formal conditions regarding collaboration on higher engineering education with international universities have been rather informal. In 2006 there were approx. 400 students going out on exchanges and 400 coming in (nearly balanced student exchange).
Following the Bologna process several collaborating universities have introduced a “3 + 2” model, where they give a bachelor of science degree after 3 years of studies and offer a 2 year master’s degree based on the bachelor of science within a relevant professional area. NTNU judges the integrated 5-year model for the master’s engineering education as a competitive advantage. This is based partly on the current relative strong recruitment situation to the integrated 5-year programmes, and the fact that this total duration is considered necessary for a good programme of study design, in particular in the multidisciplinary fields such as industrial economics and technology management, engineering and ICT, and nanotechnology. At the same time, it is realized that there is a need to find ways where students may complete their studies at NTNU with a 3-year programme and continue on with a 2-year master’s programme at another university, and make it easier for candidates with a bachelor of science degree from another university to continue in a 2-year MSc programme at NTNU.

2.4 Learning quality

Important parts of a quality assurance for learning quality were already implemented for the engineering education at NTNU when the Quality Reform was introduced in 2003, as a need for assuring quality in one common engineering education given by several faculties. During NTH's history there have been many committees to evaluate and enhance the quality of the engineering education given.

In general we operate with 6 different types of quality regarding learning,

1. Quality of incoming students (recruiting quality), as discussed in Section 2.2
2. Quality of programme of study, discussed in Sections 2.2 and 2.4
3. Quality of Graduates, discussed in Section 2.1
4. Quality of teaching
5. Quality of framework and learning environment
6. Quality of education management

Quality of learning depends mainly on four aspects, the quality of incoming students, the quality of the academic staff, learning methods and forms of assessment and the infrastructure. The way of organizing and managing the education also have a substantial impact on learning quality. More of these aspects are discussed below.

Of course the total financing of the studies is an important aspect. In addition, the student financing system as well as budget model used by the Government may be a threat to quality in education as the student as well as the institution both benefit from producing credits, and the explicitly documented requirements for knowledge and competence may be reduced.

2.4.1 Learning methods and assessment systems

The Quality Reform changed the focus from teaching to learning. This had a substantial impact on which learning methods and assessment systems were to be preferred. At the same time the budget framework was not increased to the same extent as the costs, so it was necessary to compromise. The objective of the reform was to use more student-activating learning methods and develop methods for closer follow-up of the students learning process. The practical implementations to attain these objectives resulted in wider use of project and
teamwork where the teacher should be more a facilitator in a process than a teacher. But still the ordinary lectures and exercises are the most commonly used learning method.

The purpose of using a detailed form of assessment system is to assure a more continuous follow-up and assessment of the student throughout the semester. But the widespread use of mid-term assessment is now much discussed among the teachers, where the viewpoint is that the mid-terms require too much time and administration, especially mentioned is the volume of appeals. Moreover, mid-terms give the students the wrong focus on improvement because attaining a good grade is being more important than developing better learning processes. Portfolio assessment and final examination seem to be increasingly preferred.

Internship is regarded as an important part of the learning process in the engineering education at NTNU. There has always been a requirement for a certain amount of internship in “real work life” as a precondition to start on master’s thesis work. Over the last 10 – 15 years it has been increasingly difficult to get such internship positions. The regulations for internship in engineering education at NTNU were revised few years ago. The requirement is now 12 weeks internship before the thesis in the 5-year integrated model and 6 weeks for the 2-year model. At least 50 % of the 12 week internship is to be professionally relevant, the remaining is to be relevant working experience, “to be an employee”.

There are a lot of collaboration projects between the teachers involved in MSc Engineering at NTNU and various industries. This supports the option for numerous MSc Engineering students to perform a thesis either on an industrial topical area working at NTNU, or even performing their thesis in an industrial environment. In addition, to further assist students and teachers to get relevant tasks for projects, thesis work and internship jobs NTNU initiated the development and implementation of “Idéportalen”. This is a network and a computerized system for collecting project tasks from industry and society in general for students in higher education in Norway. There are developed procedures for registration of project ideas, guidelines for quality assurance of these project ideas, and standard agreements regarding intellectual property rights and general regulations on “employees’ rights”. So far Idéportalen is well received and seems to be a very useful network.

2.4.2 Grading system and application of grades

To survey and guide the future use of the grading system, national reference panels are established by the Norwegian Association of Higher Education Institutions in the main disciplines. Within higher education in technology, all grades from MSc in Engineering at NTNU are included in this national survey. The general trend is a more frequent use of the two highest grades (A and B) compared to the total of D and E. The median is between B and C. For the master's thesis, there is even more frequent use of the two highest grades.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring courses</td>
<td>21</td>
<td>17</td>
<td>26</td>
<td>22</td>
<td>14</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Master's thesis</td>
<td>825</td>
<td>27</td>
<td>45</td>
<td>21</td>
<td>6</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

From this national survey it is recommended that the institutions focus on the communication of the description of the grades. Furthermore, it appears inappropriate that more than 70 % of the students in their master's thesis work are judged better than the supposed average
performance (grade C), and that the institutions should implement routines that ensures a more balanced practice of the grading system for the theses.

2.4.3 Quality of scientific staff

Several evaluation reports on single-courses pinpoint the quality of the teachers. Generally the teachers’ professional qualifications are judged to be high. Very often they actively are doing research activities on an international level in the same subject area as they teach, and it is common to connect exercises and project work to these research projects and thus bring motivating and updated topics to the teaching. Many of our researchers have an impressive international network, which secures a deep and broad knowledge base for the teaching. But, traditionally most of the teachers are recruited with emphasis on research qualifications, and especially within technological areas only a few candidates have a formal pedagogical qualification when they accept a permanent academic position.

During the last 15 years the pedagogical skills have been underlined and focused in the appointment process, and NTNU has developed an introductory pedagogical programme for newly appointed teachers, Pedagogical Development Programme (PEDUP), which is now mandatory for all newly appointed teachers without formal pedagogical qualifications. The programme is run by pedagogically skilled teachers from the University's Pedagogical Department (UNIPED), which also operates as pedagogical adviser for individuals as well as groups of teachers and programmes of study. There are also development projects regarding the use of ICT in teaching and learning, the use of alternative learning methods and forms of assessment, and there are awarded prizes for best pedagogical practice every year to promote and motivate teachers to improve their pedagogical performance. There are ideas and plans to develop a more systematic programme to enhance teachers’ pedagogical qualifications and pedagogical services at NTNU.

2.4.4 Infrastructure and learning environment

Due to increasing enrolment of students, introduction of new pedagogical methods, enhanced requirements on learning environment and a rapid development of ICT tools in teaching and education, it has been a substantial challenge to maintain the quality level of facilities. Despite these challenges NTNU is said to have a relatively adequate standard for its infrastructure and learning environment. This is due both to the emphasis on this aspect by the organization as well as collaboration with industry and SINTEF, to be able to maintain and further develop modern laboratories. There is current focus mainly on two areas that need attention for further improvements:
- the lack of rooms for group activities while the needs have increased/changed substantially
- the lack of resources (economic and manpower) to utilize the options in laboratory-based learning.

In principle all the students have sufficient access to the common ICT network at NTNU. Most of the students have their own PC with network card and access to dedicated computer programmes. NTNU helps the students with a reduced price on PCs, and some programmes of study obtain individual laptops for their students.

Attention to students with disabilities is emphasized in the University Act. NTNU has also put much effort to make the university accessible for students with different types of disabilities - physically, pedagogically as well as socially.
Generally many of the activities regarding the learning environment except the core learning activities is undertaken by the Student Welfare Organization (SiT), - canteens, student apartments (many with Internet, some prepared for students with disabilities), healthcare services etc. The students themselves also organize many social activities of different kinds. Last summer SiT organized a questionnaire to all active students regarding social and learning environment at NTNU, and the results were rather satisfactory.

2.5 Organization and management of engineering education

While there are four faculties giving MSc in engineering education at NTNU it is important to have a competent FUS with sufficient ability to develop solutions and make effective decisions when necessary. With the current delegated authority from the Board of NTNU and Rector, FUS feels free to operate within its main area of responsibility. This is positive, but FUS also experiences the lack of a more strategic follow-up from the university leadership. FUS also experiences a lack of more effective decision-making regarding overall issues and principal questions. After implementation of the Quality Reform in 2003 all the educational activities are more similar for all educational disciplines at NTNU, and there ought to be greater opportunities to develop more common solutions, especially within the administrative and pedagogical organization for the education, refer the Examination Regulations at NTNU and the Supplementary regulations for engineering education.

2.6 SWOT analysis with some recommendations

The self-evaluation reports from the 16 MSc Engineering programmes (Volume II of this report) conclude that the generic 5-year integrated model for the engineering education at NTNU has been successful. The model gives a broad and strong general scientific basis whereupon the student has the opportunity to build a flexible/ adaptable engineering profile, with wide possibilities to specialize his/her engineering profile in the last two years of study. To a certain degree this gives the student the possibility to decide on his/her direction of specialization relatively late in the studies, and then have the opportunity to increase the relevance of his/her professional competence profile to the needs in society at the end of his/her studies.

The management of each programme of study was asked to pinpoint the strengths, weaknesses, opportunities and threats to their programmes. There are some common trends in their comments:

Strengths:

- Strong research-based courses with great diversity, given by partly very highly qualified researchers and research groups, and many well equipped laboratories
- High level of qualifications among incoming students, good rate of applications
- Collaboration with SINTEF (solves the issue of how to employ several critical groups of researchers with high reputation which NTNU could not afford alone)
- Close network to Norwegian industry and public administration
- Strong international networks with international universities as well as companies
- Sufficient exchange of international students
- Highly acknowledged student society and learning environment
- NTNU educates approximately 80 % of Norwegian master’s engineers
Weaknesses:
- Lack of qualified applicants to certain programme of study
- There is a mismatch between number of applicants to some programmes of study and the needs for candidates in the market
- Lack of qualified professors within certain important subject areas
- Too small budgets for the maintenance and renewal of laboratory facilities
- Problems with flexibility in the curriculum connected to the rigid standardized course size

Opportunities:
- Strong international networks with universities as well as international companies. Gives opportunities for establishing alliances and collaboration agreements with acknowledged participants regarding education as well as research and dissemination.
- Close network to Norwegian industry and public administrations - gives good opportunities for projects, summer jobs and master's thesis work in companies, which gives relevance to candidate’s qualifications and good job opportunities. NTNU has the leadership of Idéportalen which seems to be a useful tool to get relevant project ideas as well as to open doors to admittance to small and medium-sized companies.
- NTNU has leading research groups within a broad domain of important scientific areas
- NTNU could give higher priority to collaboration projects with SINTEF
- NTNU has a portfolio of relevant international MSc programmes which gives great possibilities to increase the exchange of international students as well as researchers

Threats:
- Increasing international competition regarding recruitment of students as well as teachers/ researchers
- Lowered qualifications and motivation of applicants from upper secondary school and colleges
- Lack of qualified professors due to large amount of people reaching retirement age in the next 10 years and few PhD qualified candidates in the market.
- The huge negative differences in wages for professors with respect to engineers in private industry make it hard to recruit highly qualified academic staff.
- Too small budgets for maintenance and renewal of laboratory facilities
- Too small budgets for giving laboratory-based teaching
- Need for better pedagogical qualifications for teachers

Some recommendations are also given in the internal evaluation reports:
- Better integration of and stronger guidelines for electing non-technological courses
- More flexibility regarding course size and election of alternative courses (less mandatory)
- All lessons and teaching in 4th and 5th year of studies are to be given in English. This suggestion will pave the way for increased recruitment of international students without needing to establish separate educational programmes. Gives the possibility
to merge some of the current national programmes with the already established international programmes.

- NTNU should establish a possibility to give a degree *bachelor of science in engineering* (BSc) after 3 years of studies in the integrated 5-year programme. It will make it easier for our students to apply for a master’s degree at another institution or in another field of studies, and, most important, students with a BSc from another (international) institution can apply for an ordinary master’s degree programme at NTNU. It will also simplify the formal conditions regarding Joint Degree programmes with other universities.
3. Thematic Reports - International Benchmarking

In February 2007, FUS appointed four working groups under the leadership of the four Vice-Deans in the FUS Committee. Each working group was given a mandate to review selected issues, notably:

- the learning outcomes and structure of the engineering education (VK1)\(^7\)
- international benchmarking\(^8\)
- the non-technological content of the education (VK2)\(^9\)
- recruitment of students\(^10\)

Their observations and points of view were presented at a seminar 20 – 21 March 2007. Later on the Vice-Deans made written reports from their respective working group as input to the self-evaluation report. Key issues raised by the working group on learning outcomes were integrated in the mandate to the Programme Councils and further elaborated upon in their self-evaluation reports. The input from the working group on learning outcomes has, furthermore, been integrated in Chapter 2 to this report. The three other working group reports are presented in Chapters 3, 4 and 5.

3.1 International benchmarking – main issues

When the working group on international benchmarking was appointed, FUS raised a number of questions to indicate some of the most important issues:

- How does the structure and academic level of the engineering education at NTNU compare with similar educations internationally?
- In which areas and with which institutions is it the most relevant to cooperate with internationally?
- In what way is it most relevant to cooperate – joint programmes, joint degrees, student exchange, distant learning?
- How do you perceive the five-year integrated model versus a “3 + 2 model” or a “3 + ½ + 2 model” with respect to international mobility and recruitment to the NTNU master’s programmes?

3.2 Why internationalize?

Norwegian industry is becoming more international. In order to compete, it is essential that the competence in technology holds the best international levels with respect to production and development in companies, technological research and development within priority areas. For Europe it is essential to stimulate sustainable growth in technology-driven industry production in order to maintain and develop an advanced society. Today, China, Brazil and India have become powerful centres of industrial development. The EU recognizes that our

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\(^7\) Olav Fagerlid (FUS/SVT-IØT), Ola Hunderi (NT), Marvin Wiseth (IVT), John Krogstie (IME), Otto Lohne (NT), Bjørn Torger Stokke (FUS), Edina C. Ringdal (student, IME).

\(^8\) Svein Remseth (IVT), Bernt Leira (IVT), Bjørn Nygreen (IØT), Ivar Wangensteen (NT), Bjørn E. Christensen (NT), Elvind Brattebø (IVT), Johan M. Rothe (student, IØT).

\(^9\) Anne Borg (FUS/NT), Jon Rismoen/ André Liem (IVT), Kjell Wiik (NT), Stig Frode Mjølsnes (IME), Helge Brattebø (IVT), Bojana Gajic (IME), Tore Prestvik (IVT), Øyvind Ass (student, IVT).

\(^10\) Kristian Seip (IME), Trond Andresen (IME), Tim Torvatn (IØT), Trygve Foosnaes (NT), Bjørn Andersen (IVT), Ole Ivar Sivertsen (IVT), Catharina Lindheim (Student and Academic Division), Asle Opsahl (student, NT), Kjetil Hope Tufteland (student, IME), Kjersti Vrålstad (student, IVT).
education of engineering excellence will be the single decisive factor determining our future competitiveness. Many of these engineers will take on management positions in industry and through continuing education in management be able to master both technology and business challenges. The industrial renewal process must start with engineering education and Norway must be closely integrated to the European process to foster such a development.

We must educate MSc engineers at a high international level. Through cooperation with reputable universities, we can offer our students international experience, utilize each others strengths in education, and possibly release time for more research. It would be most fruitful to cooperate in areas where the universities have complementary strengths within comparable programmes of study.

If we are to cooperate with high-ranking universities, we must have something to offer. Benchmarking against reputable universities will give insight into where we have to enhance quality in order to be an interesting partner in our MSc engineering education. Cooperation in education should also lead to stronger international research networks, not least new research networks within the EU/EEA.

### 3.3 Who are we to compare with?

In the strategic thinking of NTNU and supported by political signals, it is natural to seek cooperation with the best Nordic technical universities and universities with an engineering education. The NordicFiveTech cooperation began in 2007 (KTH, Chalmers, DTU, TKK and NTNU). In Europe, NTH used to participate in the Leuven Network and the Santander Group. Today we should aim at cooperating with the IDEALeauge universities (Imperial College, TU Delft, ETH Zürich, RWTH Aachen, Paris Tech). NTNU has, furthermore, good contacts with several universities in the USA, Canada and in Asia (Japan, China and Singapore). We should aim at developing joint degrees. At the same time it gives a direct opportunity for benchmarking with our equivalent programmes of study.

International cooperation with high ranking universities will also contribute to making NTNU better known internationally. With this respect we should also mention the Erasmus Mundus Programmes which may be established through international networks in areas where our university is perceived to offer high quality education. Such programmes presuppose that we arrange for double and multiple degrees.

### 3.4 Educational structure in European engineering education

The Bologna Declaration aims to harmonize the structure in the engineering education throughout Europe to increase mobility of students and professors. Increased mobility is particularly an opportunity at masters’ degree level. Many European universities and technical colleges place a great deal of weight on basic knowledge in mathematics and natural sciences in the first part of the studies to ensure quality in their engineering education. A sufficient knowledge base will not least be important to ensure satisfactory learning outcomes for students transferring to another institution during their masters’ study.

The figure below visualizes the educational model largely supported by European universities with technology education. The structure includes the integrated five-year model, at the same time as it allows bachelor's degree candidates to enter the graduate engineering education at master's degree level to the extent that their knowledge base in mathematics and natural
sciences is satisfactory. A bachelor’s degree in engineering normally requires a fourth year of study.

If we were to transfer this European model to Norway, the integrated five-year model applied at NTNU fits neatly into the model. It would, however, be a challenge to implement a “time-for-time” policy and accept a three-year engineering degree from the university colleges as a satisfactory basis for admittance to a two-year masters’ programme. Implementing such a policy would require a political decision and cooperation between NTNU and the engineering colleges concerning adaptations to the programmes of study. Many of the students from the engineering colleges choosing to move on to an MSc engineering education at NTNU are very motivated, but may in many major and profile areas struggle with the theoretical basis. Compensatory measures for these students might be called for to improve their learning outcomes and maintain the quality at master's level.

3.5 Quality of the MSc Engineering education compared internationally

It is our perception that within most programmes of study we maintain an acceptable to high international quality level. It is, however, difficult to make an objective judgement without international benchmarking and evaluation. This is difficult as long as we do not have a common framework for learning outcomes and programmes of study. Meanwhile we may get an indication of the quality level through the international experience of our academic staff. Another source of information is our students who have spent some time at foreign universities (mainly during the 4th year) and students from foreign universities staying at NTNU during their master’s study. Within the timeframe of the working group in charge of this report, we have not considered making any systematic inquiry among students or staff. We therefore base our judgement on examples from the programmes of study which the working group members knew best.
3.5.1 Chemical Engineering and Biotechnology

The programme of study is from the outset a chemical-technical study which might be compared to what internationally is known as chemical engineering. The education offered around the world in this field of study contains by and large the same main elements. Direct comparison is difficult due to variations in the level of the basic education and the structure of the university education. In the USA, students typically are one year younger when they enter higher education, and a significant amount of humanity courses is common in the engineering education. The typical US-structure is a four-year BSc followed by a 4 to 5 year PhD. In Europe many countries are moving in the direction of the Bologna model of 3+2 years of study towards a master’s degree. The integrated 5-year MSc engineering education at NTNU should therefore be compared to the BSc+MSc in these countries. It is common with a basic science profile in the BSc and in-depth studies and specialization in the MSc. The NTNU model and the Bologna model are quite similar, but they differ with respect to the thesis (although rather limited) in the bachelor’s education.

In the table below we have compared the first part of our integrated study with similar studies at Chalmers and the BSc educations in the USA and France. We may compare the scope of the various subjects, but not the quality or level. Internationally, there are many similarities, but also variation in the way chemical engineering is taught. Various highly reputed universities have different approaches, but basically with a comparable content. The mathematics part is relatively similar, with approximately 30 ECTS during the first two years. The chemistry programme in Toulouse and at MIT both have little mathematics. NTNU, furthermore, stands out having more chemistry in comparison with the specialization in chemistry at Toulouse. The BSc education at MIT emphasizes Engineering chemistry with a focus on heavy process industry. In addition to what can be seen in the table, NTNU has a larger non-technology component in the engineering education than other comparable chemical engineering programmes elsewhere in Europe.

Table 9: Comparison of courses at NTNU, Chalmers, MIT, University of Delaware and Toulouse (2 out of 5 majors in Toulouse)

<table>
<thead>
<tr>
<th>Institution</th>
<th>NTNU 1-2.5</th>
<th>Chalmers 1-2.5</th>
<th>MIT (BSc) 1-4</th>
<th>UDEL (BSc) 1-4</th>
<th>Toulouse BSc Process</th>
<th>Toulouse BSc Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humanities</td>
<td>30</td>
<td>30</td>
<td>24</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Mathematics</td>
<td>52.5</td>
<td>45</td>
<td>24</td>
<td>50</td>
<td>66</td>
<td>38</td>
</tr>
<tr>
<td>Chemistry</td>
<td>30</td>
<td>36</td>
<td>84</td>
<td>75</td>
<td>66</td>
<td>38</td>
</tr>
<tr>
<td>Eng. Chemistry</td>
<td>7.5</td>
<td>Part of math.</td>
<td>5</td>
<td>56</td>
<td>(elective)</td>
<td></td>
</tr>
<tr>
<td>ICT/programming</td>
<td>15 (during 2.5 years)</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Environment</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Other subjects</td>
<td>56</td>
<td>56</td>
<td>56</td>
<td>56</td>
<td>56</td>
<td>56</td>
</tr>
<tr>
<td>Projects</td>
<td>15 (during 2.5 years)</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

In the USA in recent years been a debate about the content of the engineering education (chemical engineering), while the debate in Europe has been on organizational aspects to stimulate mobility (Bologna). The American debate has resulted in a proposal to revise the contents of the education along these lines:

- Change of focus from one industry (petrochemical) to many industries (based on biology, chemistry and materials)
• Maintain close linkage to basic topics (chemistry, physics, mathematics, biology)
• The core education must be evident and not too strongly influenced by niche research interests (at the same time, students must be exposed to research activities and new developments)
• Understanding of quantitative analysis, systems analysis and multiscale analysis
• Variation in the use of learning methods
• The use of examples, PBL with open problems
• Teamwork and communication skills (written and oral)
• Non-technology subjects (safety, environment, ethics, economy, laws and regulations, IP-rights, market, social relations)
• Practical training should be part of the basic education

Most of these points are already addressed in the MSc engineering education at NTNU, and it seems that the USA is coming closer to the NTNU approach.

If we compare with different engineering programmes in Europe and the USA, the NTNU programme in chemical engineering and biotechnology falls well within the “chemical engineering tradition” with respect to content and level. The specializations offered at NTNU correspond with the offers elsewhere. The NTNU scope of the basic education is rather heavy in mathematics and chemistry, comparable in physics and ICT, while (compulsory) biology is absent.

Some topics which are focused upon at NTNU are currently almost absent internationally. Examples are safety and environment. Students at NTNU meet various forms of teaching and learning, real engineering problems and open problems. In recent years, some practical training in communication skills and teamwork has been introduced in the course Interdisciplinary Teamwork, laboratory work and projects in other courses.

With the specialization (22.5 ECTS) in the 9th semester and the master's thesis of 30 ECTS, most students at NTNU will be exposed to and work on subjects approaching the research front.

3.5.2 Civil and Environmental Engineering
This example is mainly based on the work and the results of the thematic network EUCEET (European Civil Engineering Education and Training).

Categorization and scope of subjects
In the EUCEET the subjects taught in European civil engineering education have been categorized in eight subject groups and a proposal has been developed as to the recommended scope of each subject. The categorization and scope of the various subjects are listed in Tables 10 and 11.
**Table 10: Categories of subjects in the civil engineering education**

<table>
<thead>
<tr>
<th>Name of category</th>
<th>Examples of subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Basic Sciences</td>
<td>Mathematics, Physics, Chemistry</td>
</tr>
<tr>
<td>B Engineering Sciences</td>
<td>Mechanics, Strength of materials, FEM, Computer science, Drawing graphics</td>
</tr>
<tr>
<td>C Core Civil Engineering Subjects</td>
<td>Statics, Dynamics, Hydraulics, Soil Mechanics, Fluid mechanics, Elasticity &amp; Plasticity, Building materials, Surveying, Reinforced concrete, Hydrology</td>
</tr>
<tr>
<td>D Engineering Specialization</td>
<td>Steel structures, Reinforced concrete structures, Foundation Engineering, Earthquake engineering, Non-linear design of structures, Hydraulic systems in transitory regime, Hydraulic structures</td>
</tr>
<tr>
<td>E Economics and Management subjects</td>
<td></td>
</tr>
<tr>
<td>F Humanities, Social sciences, Languages and Physical Education</td>
<td></td>
</tr>
<tr>
<td>G Field Work</td>
<td></td>
</tr>
<tr>
<td>H Final Project</td>
<td></td>
</tr>
</tbody>
</table>

**Table 11: Proposed scope (in ECTS) of core subjects in the civil engineering education**

<table>
<thead>
<tr>
<th>No</th>
<th>CORE SUBJECTS IN CURRICULA FOR CIVIL ENGINEERING</th>
<th>Credits for course:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Integrated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 sem</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Mathematics and Applied Mathematics</td>
<td>19.0-27.0</td>
</tr>
<tr>
<td>2.</td>
<td>Applied Chemistry</td>
<td>3.0-4.0</td>
</tr>
<tr>
<td>3.</td>
<td>Applied Physics</td>
<td>5.5-7.5</td>
</tr>
<tr>
<td>4.</td>
<td>Computer Science and Computational Methods in C.E.</td>
<td>7.0-9.0</td>
</tr>
<tr>
<td>5.</td>
<td>Drawing and Descriptive Geometry</td>
<td>4.0-6.0</td>
</tr>
<tr>
<td>6.</td>
<td>Mechanics</td>
<td>5.5-7.5</td>
</tr>
<tr>
<td>7.</td>
<td>Mechanics of Materials</td>
<td>8.0-11.0</td>
</tr>
<tr>
<td>8.</td>
<td>Structural Mechanics</td>
<td>9.0-13.0</td>
</tr>
<tr>
<td>9.</td>
<td>Fluid Mechanics &amp; Hydraulics</td>
<td>5.0-7.0</td>
</tr>
<tr>
<td>10.</td>
<td>Engineering Surveying</td>
<td>4.5-6.5</td>
</tr>
<tr>
<td>11.</td>
<td>Building Materials</td>
<td>5.5-7.5</td>
</tr>
<tr>
<td>12.</td>
<td>Buildings</td>
<td>3.5-5.5</td>
</tr>
<tr>
<td>13.</td>
<td>Basis of Structural Design</td>
<td>3.5-5.5</td>
</tr>
<tr>
<td>14.</td>
<td>Engineering Geology</td>
<td>3.5-4.5</td>
</tr>
<tr>
<td>15.</td>
<td>Soil Mechanics and Geotechnical Engineering</td>
<td>7.5-10.5</td>
</tr>
<tr>
<td>16.</td>
<td>Structural Concrete</td>
<td>8.0-11.0</td>
</tr>
<tr>
<td>17.</td>
<td>Steel structures</td>
<td>6.5-9.5</td>
</tr>
<tr>
<td>18.</td>
<td>Timber, Masonry and Composite Structures</td>
<td>3.5-5.5</td>
</tr>
<tr>
<td>19.</td>
<td>Transportation Infrastructure</td>
<td>3.5-5.5</td>
</tr>
<tr>
<td>20.</td>
<td>Urban and Regional Infrastructure</td>
<td>2.5-3.5</td>
</tr>
<tr>
<td>21.</td>
<td>Water Structure and Water Management</td>
<td>3.5-5.5</td>
</tr>
<tr>
<td>22.</td>
<td>Construction Technology &amp; Organization</td>
<td>6.0-8.0</td>
</tr>
<tr>
<td>23.</td>
<td>Economics and Management</td>
<td>6.0-9.0</td>
</tr>
<tr>
<td>24.</td>
<td>Environmental Engineering</td>
<td>3.5-5.5</td>
</tr>
<tr>
<td>25.</td>
<td>Non-technical subjects</td>
<td>7.5-10.5</td>
</tr>
</tbody>
</table>

Core subjects total: 175.0 ECTS
Specialization subjects total: 125.0 ECTS
Total: 300.0 ECTS
Table 12 is based on an effort to compare the Civil and Environmental Engineering programme at NTNU with the EUCEET proposal. Direct comparison is somewhat difficult due to some variations in the structure of the programme of study.

Table 12: Comparison between the scope of each subject according to the proposal by EUCEET and current practice in the Civil and Environmental engineering programme at NTNU

<table>
<thead>
<tr>
<th>Subjects</th>
<th>EUCEET</th>
<th>NTNU Civil Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics, Statistics</td>
<td>23</td>
<td>37.5</td>
</tr>
<tr>
<td>Applied Chemistry</td>
<td>3.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Applied Physics</td>
<td>6.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Mechanics (+?)</td>
<td>27</td>
<td>15</td>
</tr>
<tr>
<td>Hydro mechanics</td>
<td>6</td>
<td>7.5</td>
</tr>
<tr>
<td>Computer – ICT</td>
<td>8</td>
<td>7.5</td>
</tr>
<tr>
<td>Land surveying</td>
<td>5.5</td>
<td>~0</td>
</tr>
<tr>
<td>Building materials</td>
<td>6.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Geology, Geotechnics</td>
<td>13</td>
<td>7.5</td>
</tr>
<tr>
<td>Building, Construction</td>
<td>13.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Concrete Constructions</td>
<td>9.5</td>
<td>3.75</td>
</tr>
<tr>
<td>Steel Constructions</td>
<td>8</td>
<td>3.75</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Water, Environment</td>
<td>9</td>
<td>7.5</td>
</tr>
<tr>
<td>Economics, Organization</td>
<td>14.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Drawing, Geometry</td>
<td>5</td>
<td>~0</td>
</tr>
<tr>
<td>Non-technology (incl Interdisciplinary Teamwork)</td>
<td>9.0</td>
<td>30</td>
</tr>
<tr>
<td>Core subjects total</td>
<td>175.0</td>
<td>165</td>
</tr>
<tr>
<td>&quot;Specialization&quot; subjects</td>
<td>125.0</td>
<td>135</td>
</tr>
</tbody>
</table>

**Contact time**
At NTNU and internationally, contact time is a frequently used term which is a suitable quality measure. According to the findings of the EUCEET network, the average contact time in the integrated 5-year programmes of study was 3900 hours, varying between 2700 and 5100 hours. Weekly contact time averaged 26.8 hours a week, with a minimum of 18.5 and a maximum of 36 hours a week. A comparable number for NTNU would be 24 to 30 hours a week.

**Development trends and changes – general perceptions**
Through the EUCEET network we see the following development trends and changes in the engineering education:

- Basic subjects - mathematics and natural sciences – seem to have had the same extent over the past 20-35 years, perhaps with a minor increase. Such basic subjects typically make up 20-30 % of the programme of study.
- There is a trend towards a reduction in core subjects in engineering, while specializations seem to increase. Core engineering subjects make up 20 – 30 %.
• Applied and specialization subjects are often elective. The extent varies a lot between the universities, with everything between 15 and 45 % of the total programme in these subjects.
• There is a trend in the direction of more non-technological subjects - humanities, social sciences and economics.

**Non-technological subjects**
The most important non-technological subjects can be classified in the following seven groups:

a) Subjects relating to management and economics  
b) Laws and regulations  
c) Communication and negotiation skills  
d) Humanities (including management attitudes and ethics)  
e) Arts  
f) Foreign languages  
g) Ecology and environment

Non-technological knowledge and skills are introduced through:

- *formal learning* in terms of elective non-technological subjects such as courses in communication skills
- *integrated learning* by which students gain non-technological competence in technological subjects for instance gaining communication skills through presentations/defence of term papers
- *informal learning* via participation in activities outside the formal programme, such as learning communication skills in the student radio, newspapers etc.

**Recruitment and student exchange**
More than 100 000 students annually take part in student exchanges in Europe. The exchanges may take various forms, but the total illustrates that this is an important and often integrated part of the studies for many students. The timeframe is normally up to one year. The number of student exchange agreements varies between countries. Germany, Spain, Italy and France have a high number of student exchange agreements (more than 60). In 2/3 of these agreements, the exchange is based on approval of individual courses, while 1/3 of these agreements offer a general approval semester by semester. The exchange of academic staff has fallen by about 40 % from the academic year 2003/04 till 2004/05.

**3.5.3 Industrial Economics and Technology Management**
Part of the subjects taught by the Department of Industrial Economics and Technology Management for the engineering students in industrial economics and technology management at NTNU is also taught at business schools and technical universities throughout the world. It is largely speaking only in the Nordic countries that industrial economics is offered as an engineering programme. Engineering programmes in industrial engineering are found in many places elsewhere; these studies normally have less economics than the programme of study in industrial economics and technology management at NTNU.

The NTNU programme has close contact with the comparable studies in Linköping and Chalmers. The quantitative part of our programme has many similarities with Linköping, while the qualitative part has more in common with Chalmers.
Based on informal discussing with exchange students – incoming and outgoing – the programme management has got the impression that our students have no difficulty following the courses at foreign universities (e.g. the Vice Dean of Engineering at Auckland University report that he is very satisfied with the NTNU students), while incoming students express that they have a positive learning outcome during their NTNU stay. The NTNU programme may, however, be more structured and school-like than some students are accustomed to from their home institutions (e.g. comment made by a student from Darmstadt and impressions from Edinburgh where students tended to work more independently on individual problem solving.

The engineering programme in industrial economics and technology management is largely multidisciplinary during the first three years of study. The students will thus not have reached as far in their core economic-administrative subjects during these years compared to the engineering students who to a greater extent may concentrate on their core engineering subjects. This implies that it might be less relevant for these students to be offered a degree after three years compared to other engineering students. Again this means that it is less likely that there will be enough students with equivalent knowledge to the industrial economics students, if the programme is divided in 3 + 2 years. A two-year master’s programme would probably not bring our students as far as they are within the current five-year integrated engineering programme. For the Department of Industrial Economics and Technology Management it is thus important to maintain the integrated programme.

A transition to a 3 + 2 model requiring separate admission to the last 2 years, would probably not increase the number of applicants to the technology studies at NTNU.

It is important that NTNU is visible and participate internationally, but until NTNU possibly is ranked among the 10 best technical universities in Europe, it is not likely that very many foreign students will want to take their full master’s degree at NTNU. With the current student exchange opportunities and/or joint degrees, we will probably receive more foreign students. It would, furthermore, be a prerequisite that all subjects in certain programmes of study are taught in English if we are going to have a large increase in the number of foreign students at NTNU.

In our experience, our students visiting recommended foreign universities are often perceived as good students by these universities thereby promoting and making NTNU visible abroad.

### 3.5.4 Marine Technology

This comparison of subjects and subject contents is based on information from student exchange with other universities in Europe, Brazil, the USA and Australia. At any point of time, approximately 20% of the marine technology students in the 4th and 5th year stay abroad. Their programme and subjects abroad is approved by the person responsible for the relevant specialization chosen by the student.

**Subjects offered (comprehensiveness)**

The educational offer in marine technology at foreign universities is generally less comprehensive than at NTNU, although in certain areas comparable to NTNU. It is our perception that we have a comprehensive offer of subjects fully comparable with the best internationally. As mentioned below relating to the joint programme with TU Delft, they have a broader offer in ship management and ship production. The Department of Marine
Technology is on the other hand known for having a particularly broad and good offer in hydrodynamics and structural analysis.

**Level of competence**
The level of competence largely follows the educational offer. There is generally a rather good correspondence between the research activity at the Department and the educational offer (in the latter years of study). Repeatedly students returning after a period of study abroad, have to take courses at lower levels in order to catch up for their specialization. The work load per ECTS credit varies significantly between different universities; in particular certain universities in the USA have a heavy work load.

**Requirements as to previous knowledge**
The students have in most cases good previous knowledge. For our students, the choice of subjects at an equivalent level abroad is largely unproblematic.

**Forms of teaching and examination**
The types of teaching methods and follow-up differ at some universities from what we are accustomed to at NTNU. There is in particular large variation in the use of project work and mid-term examinations.

**General impression**
The general impression is that the programme of study in marine technology at NTNU has a scope and level at the forefront internationally. There are, nevertheless, universities who may offer a wider and better offer in special areas as the description of the cooperation with TU Delft below illustrates.

**Joint programmes of study between TU Delft and NTNU**
We have started a joint programme of study in the 4th year for students at TU Delft and NTNU. It involves NTNU students who have chosen to specialize in Marine Design and Marine Engineering. A stay in Delft is compulsory for NTNU students who have chosen these specializations.

In the first round of this joint programme cooperation the students spent the autumn semester 2006 at NTNU and the spring term 2007 at TU Delft. Practical matters - enrolment, stay and exams - are handled by the partners. Initially we will have 10 to 12 students in this joint programme, but the aim is to gradually expand.

TU Delft is recognized as one of the top 10 technical universities in Europe. TU Delft – Department of Marine & Transport Technology – has, furthermore, a complete programme in marine activities. The programme of study is thoroughly prepared and has a very good quality. The subjects offered are, not least, largely complementary to what we offer at NTNU.

### 3.5.5 Statements made by two foreign students from Germany

**German student from Technical University Darmstadt**
I took my master’s degree in industrial economics in 2002 at the Technical University Darmstadt, Germany. From August 1999 until June 2000, I was an exchange student at the Norwegian University of Science and Technology in Trondheim. During this year, I followed
two classes at the Department of Industrial Economics and Technology Management (Operational Analysis 2, in fall 1999 and Operational Analysis 3, spring 2000), and one class at the Department of Materials Technology (Materials Technology 2).

The two classes in Operations Research corresponded to the exam in the OR specialization, whereas the class in Materials Technology was recognized as equivalent to the class taught at my home university.

The general impression I had (which is – of course – entirely subjective), was that the Norwegian system of teaching is more organized than the German system. It is more like a school, thus also requiring less independent work by the student. As much as I like the clear structure, I think it is an advantage of the German system to put more responsibility on the student.

A big advantage of the Norwegian system is the availability of the teaching staff. The professors were in general always willing to answer questions and help in solving all kinds of problems. The standard in Darmstadt is that here is one hour in the week the professors sees his students. The rest of the teaching staff usually has also just one hour per week each, which is a big contrast to the common open-door-policy I experienced while staying at NTNU in Trondheim.

Experiences of a German exchange student
Frank Henning was an exchange student at NTNU Department of Marine Technology in the academic year 2002-2003. He describes his experiences as an exchange student in this way.

The reason for choosing NTNU as university for an exchange period was twofold. Norway has a reputation for being a shipping nation and a good maritime education is expected. In addition it seemed to be an attractive foreign country in which English is a common language. Course lists were available which claimed flexibility in the language of instruction.

It turned out that it was no problem to communicate in English; however, there was in fact no flexibility in the language of instruction. My concerns about me being able to follow courses without having the same background as Norwegian students turned out to be unnecessary. My impression was that the education in Germany (in engineering at least) is to a greater extent based on theory, e.g. in mathematics or engineering subjects, which enabled me to tackle the problems I studied in Norway without too much trouble. In my studies in Germany heavier weight was placed on the delivery of well done exercises (both content and layout) and a deeper in-detail understanding of the study material was expected. That attitude made it relatively easy to succeed in my studies in Trondheim.

I came to Trondheim also because I could take classes which were not offered at my university at home. In fact, the content of those courses was much more interesting than what my own institute had to offer. The content was closer to real and current applications. Altogether my studies in Trondheim were very motivating for me.

Apart from problems which arose out of language, some administrative issues posed difficulties for me. In some sense I had to fit in the Norwegian course system. I was not allowed to take subjects from different lines of study and I had to take the same type of exams as the Norwegian students. Since my university’s regulations about exams were different from the NTNU regulations, I had difficulties to get a type of exam which would be acceptable in
Germany. In general, I got the impression that it is not very beneficial if foreign students have to fit in the host university’s study system or if the home university insists on the use of their regulations.

My studies in Trondheim were closer related to real applications. Group work was expected to a greater extent and a greater responsibility in how to interpret exercises was demanded of the students. The study material covered a broader range of topics and put less emphasis on the understanding of the theoretical or practical foundations. I perceived the studies as motivating. In Germany exercises were defined more precise, but had to be carried out with greater care. There was less responsibility in interpreting assignments, but there was greater responsibility in organizing one’s own studies. The studies were less structured. I realized that I had great benefit from my methodical and theoretical background. At the same time it was less motivating to study large amounts of theory. In general, the studies were less broad with greater emphasis on the theoretical foundations.

If I would have taken my whole studies in Norway, I believe I would have had motivating studies and as a result great belief in being able to find creative solutions to industry problems. However, I am convinced that the base for solving industry problems was laid in Germany. I perceive the theoretical part of the education as a crucial element that is less emphasized in Trondheim.
4. Thematic reports - Non-technological Courses in the Engineering Education

The working group appointed by FUS to review the non-technological courses in the Engineering Education (non-tech), were invited to address and give recommendations regarding the following topics:

- Interplay and integration between non-tech courses and other courses during the engineering education.
- How to include entrepreneurship and innovation in the MSc engineering programmes of study?
- Globalization/project management/economics/ Intellectual properties/Legal issues as part of the engineering studies.
- Interdisciplinary Teamwork as a course in the engineering studies.
- Which possibilities for non-tech courses are available at NTNU and which are most relevant for the engineering studies?

4.1 Background

4.1.1 Recommendations from the Curriculum Development Committee

The amount and content of non-tech courses were originally described by the Curriculum Development Committee in their first report (VK1:1993). In VK1 it was recommended that non-tech courses should comprise half a year of study (30 ECTS) with 4 courses of 7.5 ECTS. The motivation for including such courses in the programmes of study was to place engineering into a social context. These courses could either be directed towards the engineering profession or be of a more general character. An introduction to philosophy (Ex. phil) for engineering students was to be included in one of these courses. VK1 included the following topics in their recommendations: ethics, law topics, communication skills, environmental topics, organization, psychology, languages, technology history, and economics.

One of the other recommendations from VK1 was that all engineering students were to carry out an interdisciplinary project during the 8th semester. The project was to be performed in groups of students coming from different programmes of study or Faculties. This interdisciplinary project was the basis for Interdisciplinary Teamwork, which initially was a course for the engineering studies only, but later has been developed to a common course for all master's students at NTNU.

The non-tech courses were reviewed through the work carried out by Curriculum Development Committee in their second report (VK2:2003). The committee agreed that the engineering studies should include 4 non-tech courses. IKKETEK 1 (Ex.phil.) was recommended placed in the 4th semester rather than the first. IKKETEK 2 was suggested as a compulsory course “Technology Management”, placed in the 5th semester and with the following topics:

- Organization and management/Work and organizational psychology (30%)
- Economics (30%)
- Legal issues (30%)
- Business development and innovation (10%)
VK2 recommended that IKKETEK 3 was placed in the 7th semester and chosen from a list of courses selected by the Programme Councils, suitable to the profile of the various programmes of study. Finally, VK2 suggested IKKETEK 4 to be chosen freely by the students among courses provided at NTNU and placed in the 9th semester. VK2 also recommended that NTNU offers opportunities for graduate engineers to take further and continuing education in non-tech courses.

4.1.2 Courses that are common to all NTNU students

According to the Act relating to Universities and University Colleges, the Ministry of Research and Education may require that specific courses up to 20 ECTS must be included as part of any academic degree programme. Today an introductory course in philosophy (Ex.phil) is required by the Ministry. The Board of NTNU has decided that at least 20 ECTS of “common courses” is to be included in all bachelor's and integrated MSc programmes at NTNU. This requirement comprises 3 courses: Course 1 is Ex.phil, Course 2 is Ex.fac. and Course 3 is a so called “perspective course”. The first two courses are preferably to be part of the first year of study.

The Executive Committee for Education at NTNU gave the following guidelines for the perspective course: NTNU has a special responsibility with respect to interdisciplinary cooperation. The perspective course is to give the students training in a different scientific tradition and approach and give insight into new areas. Moreover, it is to broaden the perspectives of the studies chosen by the students and provide insight in their own and other disciplines as well as serving as a basis for future interdisciplinary collaboration and communication. For the engineering programmes, FUS, decided to assign IKKETEK 3 as the perspective course.

A list of perspective courses is decided by the Executive Committee for Education at NTNU every academic year. The requirement is that the course chosen is to represent a different study culture. The lines between study cultures are drawn between different organizational units but such that technology, natural sciences and mathematics are seen as the same study culture. This means that only one department providing courses for the engineering studies, Department of Industrial Economics and Technology Management (IØT), is allowed to offer courses for IKKETEK 3 and IKKETEK 4. Only the MSc in Industrial Economics and Technology Management programme does not have this requirement on non-tech courses as it already containing a mixture of economics and engineering.

4.2 Current status - non-technological courses and Interdisciplinary Teamwork

Currently, the status of the non-tech courses in the engineering studies is rather weak, both among the engineering students and the academic staff. The working group finds that the term “non-tech” gives associations to topics not being relevant to the engineering programmes and that it thus contributes to lower the recognition of these courses. The attitude, both among students and academic staff, is that these courses are of little relevance to the engineering studies. This is evident from the answers to some of the questions addressed by selected engineering programmes during the self-evaluation process. The term “non-tech” also implies a distinction from technological courses, which may be an asset or drawback depending on the role these courses play in the engineering programmes. This issue will be addressed below. In the following, we comment on the current status of each of the non-tech courses.
4.2.1 Ex.phil. (IKKETEK 1)
The engineering students find that the introductory course in philosophy (Ex.phil) is of little relevance. One reason is that the content of the course has not been directed towards the study interests of these students as recommended by VK1. When entering university studies, the students are eager to learn as much as possible within their own field of study at an early stage. Moreover, the suggestion from VK2 regarding connecting the IKKETEK 2 course Technology Management to Ex.phil., has not been followed up. Except for a couple of engineering programmes, these two courses are now taught with significant separation in time.

4.2.2 Technology Management (IKKETEK 2)
The course content of Technology Management is today in line with the recommendations from VK2. The topics suggested by VK2 were carefully chosen based on a survey performed. The feedback from the students is that the content of this course is an important part of their studies. However, the course contains too many topics to be covered in too limited time and for this reason appears fragmented. Therefore the content of this course needs reconsideration.

4.2.3 IKKETEK 3 and IKKETEK 4
The engineering students choose IKKETEK 3 from a list of perspective courses. IKKETEK 4 can, in principle, be chosen among all courses available at NTNU, provided that the definition given for the perspective course is fulfilled. However, to a large extent students are also choosing this course (IKKETEK 4) from the list of perspective courses. It should be noted that the number of courses available on this list decreased significantly for the academic year 2007/08 due to the economic situation at the faculties. In the table below, the choices made by the engineering students in 2006 are given. In particular, “Medicine for Non-Medical Students, Introduction”, is a favourite course to a large number of students, even though this course is of clear relevance to only a selection of the programmes of study. The reason for this popularity is at least twofold: Medical topics are of general interest to the individual, and in this course the students have been graded based on a multiple-choice exam with marks Pass or Fail. This practice has made it possible to pass the exam with limited effort.

At present, the non-tech courses available for the engineering students and the choices made by the students fulfil the intentions given in VK1 and VK2 to only a limited extent. The Programme Councils have had no influence on the choices of the students, except for those programmes, which have made a specific topic for IKKETEK 3 compulsory to all of their students. Thus, the current regulations led to weak interplay between IKKETEK3 and IKKETEK 4 and other courses in the programmes of study as well as with Technology Management (IKKETEK 2). As a result, the relevance is not seen by the students, a situation which results in low motivation and a minimum work load invested.
Table 13: Perspective courses chosen by the students in 2006 (IKKETEK3 and IKKETEK4)

<table>
<thead>
<tr>
<th>Course</th>
<th>Number of engineering students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicine for Non-Medical Students, Introduction</td>
<td>516</td>
</tr>
<tr>
<td>Spanish 1</td>
<td>97</td>
</tr>
<tr>
<td>Operations Research, Introduction</td>
<td>89</td>
</tr>
<tr>
<td>German 1</td>
<td>71</td>
</tr>
<tr>
<td>The Cultural Dimension of International Business</td>
<td>63</td>
</tr>
<tr>
<td>Design as a Creative Process</td>
<td>55</td>
</tr>
<tr>
<td>Work and Organizational Psychology</td>
<td>43</td>
</tr>
<tr>
<td>French 1</td>
<td>40</td>
</tr>
<tr>
<td>A Different Country</td>
<td>39</td>
</tr>
<tr>
<td>Energy, Environment and Society</td>
<td>36</td>
</tr>
<tr>
<td>Psychosomatics and Health Psychology</td>
<td>33</td>
</tr>
<tr>
<td>Digital Communication and Organizational Challenges</td>
<td>30</td>
</tr>
<tr>
<td>Market Oriented Product Development</td>
<td>27</td>
</tr>
<tr>
<td>Italian 1</td>
<td>26</td>
</tr>
<tr>
<td>Production Economics and Markets</td>
<td>25</td>
</tr>
<tr>
<td>Legislation of Environment and Natural Resources – Plan. and Manage.</td>
<td>19</td>
</tr>
<tr>
<td>Health and Working Life</td>
<td>16</td>
</tr>
<tr>
<td>IT-based Organizational Development</td>
<td>11</td>
</tr>
<tr>
<td>Japanese Culture</td>
<td>10</td>
</tr>
<tr>
<td>Evaluation of Political Risk</td>
<td>9</td>
</tr>
<tr>
<td>Group Processes, Organization and Leadership</td>
<td>8</td>
</tr>
<tr>
<td>French 2</td>
<td>7</td>
</tr>
<tr>
<td>Natural Resources Management – Theories and Concepts</td>
<td>7</td>
</tr>
<tr>
<td>Our Global Society</td>
<td>5</td>
</tr>
<tr>
<td>Psychological Anthropology</td>
<td>4</td>
</tr>
<tr>
<td>Ethics</td>
<td>3</td>
</tr>
<tr>
<td>Globalization</td>
<td>3</td>
</tr>
<tr>
<td>Academic Thinking and Presentation of Academic Work</td>
<td>3</td>
</tr>
<tr>
<td>Organizational Design and Information Technology</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total number of students</strong></td>
<td><strong>1297</strong></td>
</tr>
</tbody>
</table>
4.2.4 Interdisciplinary Teamwork

Substantial resources are allocated to the course Interdisciplinary Teamwork at NTNU. The working group notes the same challenges for this course as pointed out by the Strategic Committee on Interdisciplinary Teamwork (spring 2007). In general, the engineering content of this course is considered too weak for the engineering students, and the learning outcomes vary dramatically depending on which “village” the students have been assigned to. It should be emphasized that when asked, many students answer that they have learned about group dynamics and processes during this course. However, the committee is of the opinion that this (important) part of this course also depends on having adequate professional problems to be addressed by the various groups.

4.3 Discussion and recommendations

In general, the working group has used the work done by VK1 and VK2 together with input from the different programmes of study as a basis for its recommendations. The reason for this is that the studies done by VK1 and VK2 to chart the opinion of the “market” for engineers still are our most important source of information regarding the relevance to the work market for those with MSc Engineering education at master's level. Because the work and recommendations of VK1 and VK2 partly took place before - and independent of - the national and local regulations (common courses for all students), we do not find it appropriate to discuss non-tech courses as part of the engineering programmes within a framework that is in conflict with the regulations set by the Board of NTNU. Therefore, the working group wants to take a pragmatic approach in which the regulations that are valid for all NTNU students become an integral part of this discussion.

The working group finds that most points where we are not satisfied with the current situation are where the suggestions and recommendations of VK1 and VK2 have not been followed. Another evaluation should be done four years from now to see whether the changes recommended below (if implemented) have increased the satisfaction with respect to learning outcomes and relevance.

4.3.1 Status and level of the non-tech courses

In general, the working group is concerned about the reputation of the non-tech courses in the engineering studies. They are not fulfilling the goals of VK1 and VK2 in the present form and are not regarded as relevant by the students and partly not by the academic staff. The committee strongly recommends that measures are taken to improve this situation. A change of name for these courses is imperative, and the committee suggests that they should be called “Complementary courses”.

The working group finds that the existing portfolio of “Perspective courses” is experienced as irrelevant. Courses offered are not geared towards being relevant to the engineering students. Instead, existing courses, usually at the bachelor's level in other programmes of study in medicine, humanities or social sciences are offered to the engineering students. This creates severe problems with relevance and with respect to the level of the courses. IKKETEK3 and IKKETEK4 are both coming at a late stage in the engineering programmes and should hold at least a third year bachelor’s level, taking into account that the students are mature at this point in their education. In this respect, the working group recommends that IKKETEK 3 and
IKKETEK 4 should be above introductory level, i.e. above the 1000 level which corresponds to introductory/basic courses during the first 2 years of study in a bachelor’s degree.

4.3.2 Number of Complementary courses
The working group has been discussing the amount of complementary courses in the engineering programmes. The different engineering programmes and specializations have different requirements in terms of professional and complementary courses. Moreover, the interests of the students vary widely. Based on these considerations the working group suggests that in addition to Ex.phil. and Technology Management at least one more complementary course should be compulsory. In addition, depending on the requirements given by the Programme Councils and/or FUS, one (or even two) more complementary course can be chosen. A description of how this can be done is outlined below.

4.3.3 Course content and organization

*Ex.phil.*
Most engineering programmes find the existing IKKETEK 1 to be of little relevance. To solve this problem and strengthen the role of Ex.phil. in the engineering programmes, the working group recommends that the content of Ex.phil. for engineering students is changed in direction of topics of particular interest for this field in accordance with the original recommendation given by VK1. The precise content of such a changed course needs to be discussed, but may include science theory and science history with emphasis on engineering and natural sciences. The committee believes that this will strengthen the relevance of this course among the students and also make it a more integrated part of the engineering programmes. On the other hand, it can be argued that having a “different” course like Ex.phil. during the first year of university studies may provide a sound, topical contrast to the courses in mathematics, science and introductory engineering. If a link is to be obtained between Ex.phil and Technology Management, these two courses need to be placed in sequential semesters. For a couple of programmes this is the situation already today, and it seems to be a good solution, even though there are no obvious links in content between these two courses as they are taught today.

The current flexibility with respect to which semester Ex.phil. is taught in the different programmes of study, is considered as an asset for the overall structuring of the courses in the programmes. The working group recommends that this flexibility is maintained also in the future. A good overall structure of programme specific courses and basic courses in mathematics, natural sciences and computer science during the first part of the programmes of study is more important in this respect. Due to its status through national regulations, it is recommended that Ex.phil. is referred to with its proper name rather than “Complementary course 1”.

*Technology Management*
The working group has discussed the content and status of Technology Management. As it has been developed in accordance with the recommendation given by VK2 and the topics included in the course were chosen as a result of thorough investigations of what former students and representatives of the companies and organizations employing engineers believe should be taught, the working group recommends that Technology Management continues as a compulsory course for all engineering students and suggests that it is referred to as “Complementary course 1”. This course includes topics, which should be part of all
engineering programmes of study. However, the number of topics covered by the course should be reduced. Thus, the working group supports the suggestions made by IØT, that legal issues are removed as topic in Technology Management. Legal issues require the introduction of so much basic terminology and understanding that it is not compatible with covering several other large topics in the same course. A new, full course covering legal issues more deeply should therefore be offered as an elective possibility under Complimentary courses 2 and 3 (see below).

The current flexibility, with respect to which year and semester Technology Management is included in the different programmes, is considered as an asset for the structuring of the courses in the programmes. This flexibility should be maintained also in the future.

**Complementary courses 2 and 3**

Regarding Complementary course 2 the working group again wants to turn the attention to the recommendations given by VK2 on IKKETEK 3, but also to the original suggestions by VK1. According to VK2, IKKETEK 3 should be chosen on the level of the programme of study. In addition, care should be taken to ensure a sufficiently high level of the courses offered and ensure relevance through a choice between a limited number of courses. The working group recommends that Complementary course 2 is regarded as “Perspective course” for the engineering programmes.

In Table 14, two options are illustrated. Option 1 has a total of three complimentary courses, whereas option 2 requires only two complimentary courses and has a choice among a technological course and complimentary course 3. It should be noted that even one more complementary course can be selected at the expense of “the engineering course from a different engineering programme” during the 4\(^{th}\) year.

**Table 14: Illustration of the options with respect to Complementary course 2 and selection of Complementary course 3 or a technological course**

<table>
<thead>
<tr>
<th></th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>4(^{th}) or 5(^{th}) year</td>
<td>Complementary course 3</td>
<td>Technological course/Complimentary course 3</td>
</tr>
<tr>
<td>3(^{rd}) or 4(^{th}) year</td>
<td>Complementary course 2</td>
<td>Complementary course 2</td>
</tr>
<tr>
<td>2(^{nd}) or 3(^{rd}) year</td>
<td>Technology Management*</td>
<td>Technology Management*</td>
</tr>
</tbody>
</table>

* Technology Management = Complementary course 1

There were different views with respect to these alternatives (options) in the working group. Some argue that the norm should be three complementary courses (option 1), and that option 2 should be an exception which should be discussed with FUS in each case. This view is founded on the work by VK2 and its recommendations regarding strengthening different complementary aspects of the programmes including topics like organization, legal issues, entrepreneurship and IPR. However, there is a considerable topical spread among the various (16) programmes of study and some have problems finding sufficient room for their technological specialization courses. Consequently, some members of the working group argued that it is more important to address this problem than requiring a fixed number of complementary courses. The boards of the programmes of study have the expertise to make the suggestion concerning options 1 or 2. The most flexible situation would be to let the individual student choose between Complimentary course 3 and a technology course, based on their academic interests. It should be up to the programme councils to suggest if this alternative should be possible for their students.
To ensure sufficient level and progression between the complementary courses, the working group recommends that a selection of “building blocks” is offered to the engineering programmes. Each “block” should consist of complementary courses building on each other in order to ensure progression and a sufficient level of these courses. Students who take two or more such courses will then have a group of courses, which functionally could comprise a “minor”. A list of suggested “blocks” building on Technology Management is described in the textbox below. Each engineering programme can then decide which “blocks” are relevant for its students, including “blocks” not directly building on Technology Management. The number of “blocks” for each programme should be limited and the working group suggests an upper limit of 5 “blocks”. If necessary, the programme could also list one “block” as their only choice. This would in effect make Complementary course 2 (IKKETEK 3) a compulsory course in that programme. The available blocks should be approved by FUS.

Currently IKKETEK3 and IKKETEK4 are taught in the autumn semesters - the 7th and 9th semesters, respectively. The working group foresees no change in this respect for Complementary course 2 and 3 unless Technology Management is taken at an early stage in the programme of study, which opens for a Complementary course 2 already in the 5th semester and Complimentary course 3 in the 7th semester. Flexibility with respect to autumn or spring semesters may be considered if some of the courses attract so many students that parallels can be provided.

### 4.3.4 Interdisciplinary Teamwork (EiT)

In the context of the total amount of non-tech courses in the curriculum, the committee wants to emphasize that the engineering content and relevance of the course EiT has to be improved. Again, the interplay between professional and group dynamics contents of this course must be stressed. Also, good quality learning outcomes must be obtained for all students independent of villages. The committee wants to underline the importance of addressing engineering problems based on proposals from industry or other external “customers” in the project part of EiT. The competence required for attacking these problems should be reflected in the disciplines to be covered by the group members in the villages.

If NTNU is not able to develop EiT in this direction, the committee recommends that it be made elective. If NTNU chooses to keep this course as compulsory without strengthening the engineering content for the engineering students, the committee suggests that it is turned into a perspective course. It should however be stressed that the committee feels that making EiT an elective course or a perspective course in the long run will be detrimental to this course.
### Examples of possible “blocks” for Complementary course 2 and 3.

*Existing courses are listed with their course numbers (incl. Department abbreviation), courses that should be revised or new courses are marked with xxx.*

**Economy and accounting block:**
- Complementary course 2:
  - TIØ 4111 Economy and accounting (finance and internal accounting, accounting principles)
- Complementary course 3:
  - TIØ 4142 Finances and investments (investment analysis, financial issues related to loans, real and capital investments, disk analysis) or
  - SØKxxxx Macroeconomic Project Evaluations (how to evaluate projects and the impact they have on the societal level)

**Entrepreneurship and innovation block:**
- Complementary course 2:
  - TIØ4230 Market oriented Product development (product development and commercialization)
- Complementary course 3:
  - TIØ4320 Strategic Negotiations (negotiations connected to external investments for enterprise establishment) or
  - TIØxxxx Contract Law and Intellectual Property Rights

**Legal issues block:**
- Complementary course 2:
  - TIØ xxxx Contract Law and Intellectual Property Rights
- Complementary course 3:
  - TIØ4xxx Company Law and Labour Law or
  - TIØ4xxx Environmental Law and Corporate Social Responsibility

**Organizational development block:**
- Complementary course 2:
  - TIØ5200 Project Organizations
- Complementary course 3:
  - SISxxxx Virtual organizations and change management
  - SISxxxx Organizations and the use of ICT

**Project Management block:**
- Complementary course 2:
  - TIØ5200 Project Organizations or
  - TIØxxxx Project Economics and investments
- Complementary course 3:
  - TIØ5215 Programme and Portfolio Management or
  - SØKxxxx Macroeconomic Project Evaluations (how to evaluate projects and the impact they have on the societal level)

**Intercultural work environments block:**
Courses given by geography and anthropology.
4.4 Summary

As part of the evaluation of the 5-year integrated Master of Science in engineering programmes at NTNU, a committee was appointed to discuss and give recommendations regarding the courses included in these programmes entitled non-tech courses as well as on the interdisciplinary course Interdisciplinary Teamwork. The recommendations from this committee are given in this report. The main aspects that need to be strengthened for the non-tech courses are their relevance, academic level as well as their progression. The main recommendations are:

- The term “non-tech” courses should be omitted. The committee proposes the term “complementary” courses.
- All complementary courses must be at an appropriate academic level.
- The content of Ex.phil. (IKKETEK 1) should be revised with the aim of changing the curriculum to include more relevant topics for the engineering students.
- The course Technology Management (TIØ 4258) is recommended kept as an obligatory course for all engineering programmes, but with a reduced number of topics. More specifically, it is recommended that Legal issues are not taught in this course.
- The flexibility with respect to the semester where Ex.phil. and Technology Management are taught in the different programmes of study, should be continued.
- As a minimum, one more complementary course, in addition to Ex.phil. and Technology Management, should be obligatory. This is the Perspective course, which is obligatory for all BSc and integrated MSc programmes of study at NTNU.
- It is recommended that the complementary courses are chosen as “building blocks” with progression from one course to the next and that a limited number of these “blocks” is chosen for each programme of study.
5. Thematic Reports - Recruitment of Students

The working group appointed by FUS to review recruitment of students, was asked to address and give recommendations regarding the following topics:

- Relevance of Science Education (ROSE project). How to use the information about young people’s preferences in the recruitment strategy?
- The strategy for natural science of the Ministry of Education and Research – what can we do at NTNU?
- Admissions requirements – entrance tests - different paths to admission
- Insufficient background – who ensures that young people can improve their qualifications – a year zero at the universities?
- International dimensioning and recruitment – which international master’s programmes in engineering should NTNU have and which joint degrees and joint programmes?

The working group has collected some relevant statistics about national and international recruitment, and has provided information about the completion rate among students admitted to the engineering education at NTNU (see Section 5.4). The working group focused on recruitment of students to the 5-year integrated engineering education at NTNU, but has not discussed recruitment of students with a bachelor’s degree in engineering from Norwegian university colleges.

5.1 The general picture

Engineering education at NTNU should have two main goals for its recruitment policy:
- achieve and sustain strong national recruitment
- build strategy for international recruitment policy

We begin by addressing the challenges related to the first goal. ROSE (Relevance of Science Education, see http://www.ils.uio.no/english/rose/) is an international comparative research project intended to shed light on factors of importance to the learning of science and technology. The target population is students towards the end of secondary school (age 15). The results of ROSE are highly relevant for a discussion of recruitment of students to the engineering education at NTNU. In short, the results so far reveal that young people seem to acknowledge the importance of science and technology, but in highly developed countries, that does not seem to affect their choice of career: Remarkably few are interested in working in these fields, and this lack of interest is particularly strong among females.

There is a widespread international concern about this situation, clearly visible in official EU policy statements, such as the EU’s Science and Society Action Plan. In Norway, the Ministry of Education and Research has launched a strategy and an action plan (2006), “Et felles løft for realfagene”, to increase the recruitment of young people to science and engineering education. There is broad participation from industry and society at large in this political initiative.
Over the last three years, the annual number of upper secondary school graduates that fulfil the formal requirements for admission to engineering studies at NTNU, has been slightly more than 5000. On the other hand, some 1300-1400 students are admitted every year; the number of applicants with engineering studies at NTNU as their first priority has been roughly twice the number of students admitted. This means that roughly half of those formally qualified for engineering studies at NTNU apply, and roughly one quarter of them are admitted. These numbers indicate broad national recruitment as well as crucial dependence on such recruitment. Demographic predictions show no drastic changes in this situation towards 2020.

The main concern is that roughly 10% of Norwegians of age 19 have the required upper secondary school curriculum for admission to engineering education at NTNU. This percentage, which is low even in comparison with other highly developed countries, is in accordance with the findings of the ROSE project.

A peculiarity that affects the recruitment policy of NTNU is the fact that NTNU is not only an engineering school; it is also a comprehensive university with a broad range of research and education within fine art and the humanities, the social sciences, architecture and medicine. While NTNU has a national position and responsibility within the field of engineering, its recruitment policy must always be sufficiently balanced so that the whole spectrum of disciplines is clearly visible. Finding the right balance is not an easy task; NTNU as an engineering school is an institution with a strong and leading national position, while NTNU as a comprehensive university is one among seven universities in Norway.

Figure 6 shows that the number of 19 year olds in Norway will increase from about 55 000 in 2007 to about 65 000 in 2011, a number that will be quite stable until 2020. Based on such national trends, one may predict that the number of applicants may increase quite significantly over the next few years.

Figure 6: Projection until 2020 of the number of 19 year olds in Norway.
Source: Statistics Norway (SSB)

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11 The formal requirement was until 2006 3 years of the highest level of mathematics and two years of the highest level of physics (or some equivalent of this) from upper secondary school. From 2007, as a 2-year trial project, an additional requirement was added: mark 4 or higher in the third year of upper secondary school mathematics. (Marks 1-6, with 6 the highest mark.) As a result, the number of upper secondary school graduates that are formally qualified, has dropped significantly from 2007.
5.2 Organization of recruitment work at institutional level

5.2.1 National recruitment

At the institutional level, the work promoting recruitment of students is conducted by a group of four consultants in the Student and Academic Division, Section for Recruitment and Student Admission ("the recruitment unit"). In addition, much work is done at the Faculty and department levels as well as within the different programmes of study. Currently, the recruitment unit is working out an overview of such activities, aiming at running NTNU’s activities as efficiently and coherently as possible. The self-evaluation reports of the individual programmes of study give descriptions of some of this work.

The recruitment unit is governed by the Steering Committee for Recruitment which meets 5-6 times a year. The committee is currently composed of:

- Pro-Rector for Education and Quality of Learning
- Information Director
- Director of the Student and Academic Division
- Dean of the Faculty of Arts
- Faculty Director, Faculty of Natural Sciences and Technology
- A scientific representative from Faculty of Engineering Science and Technology
- A student representative

In addition, an administrative body named Forum for Recruitment has been established, in which representatives for all Faculties, Information Division, Section for International Relations, “Females & Data”\(^\text{12}\) and the Executive Committee for the Engineering Education take part. This group meets every two or three weeks, and it:

- constitutes a discussion forum for NTNU’s work on recruitment and serves as an advisory body for the recruitment unit,
- gives information about recruitment efforts to and from the Faculties and departments,
- has operational responsibility for several tasks conducted at institutional level (like production of folders and participation in education fairs).

Strategic guidelines for the work of the recruitment unit

The recruitment unit should promote all programmes of study at NTNU, but put additional weight on its main profile. In addition, the recruitment unit should give priority to the following aspects:

- Its primary target group is young people aged 17 – 21
- Recruitment from certain selected geographical regions, such as Trondheim, Oslo, Bergen, Stavanger, and surrounding areas of these cities
- Recruitment of female students to engineering education
- Recruitment of students belonging to a lingual minority group

\(^{12}\) A project aimed at increased recruitment of female students to ICT studies.
- Recruitment of students to the 2-year international MSc programmes at NTNU.

Activities

The following is an overview of the most significant activities of the recruitment unit:

- Participation at major higher education fairs (approximately 10 in Norway)
- Upper secondary school visits (the number of schools visited has in recent years increased from approximately 200 to close to 300)
- Visits of upper secondary school students to the campus (significant increase of number of visits in recent years)
- “Teknolos” (project aimed at motivating pupils in 10th grade for mathematics and science; these are 15 year old pupils in secondary school that are about to choose their upper secondary school education)
- Marketing (Newspapers, magazines, cinema commercials etc.)
- Production of folders
- Seminars and general information for upper secondary school advisers

An anomaly in the organization of recruitment activities, is that the Information Division (under the Director of Organization and Information) is responsible for the recruitment web [http://www.ntnu.no/](http://www.ntnu.no/). An administrative webforum with representatives from the Faculties takes care of the development of the recruitment web, and the members of this group are responsible for keeping the web pages of the respective Faculties updated. There is partial overlap between this group and the Forum for recruitment.

5.2.2 International recruitment

The recruitment unit is also responsible for recruiting self-financing students to the two-year international MSc programmes. This is a relatively new task. So far, the following organizational moves have been made:

- A working group with representatives from the recruitment unit and the Section for International Relations has been established (both units are within the Student and Academic Division).
- There has been a meeting with those responsible for the 2-year international master’s programmes, a group that is likely to be developed as a consulting body for the work group, much as Forum for Recruitment is for the work on national recruitment.

Activities

A number of activities have been launched, among these are:

- Production and distribution of a catalogue of international MSc programmes
- Production of English web pages
- Agreement with Student Recruitment Media (SR Media)
- “Polish ambassadors” (local student representatives at Polish universities)
- Production of an “information package” for NTNU students and employees travelling abroad
- NTNU was responsible for the 19th Annual EAIE conference (September 2007)
• Collaboration with ESN (European Student Network) about using students travelling abroad as “ambassadors”, as well as about spreading information among foreign students at NTNU.
• Stands at educational fairs in Berlin, Minneapolis, and St.Petersburg during 2007.

A number of additional activities and actions are being planned. However, strategic guidelines are still missing. A need for such guidelines is strongly felt by the recruitment unit.

5.3 Important factors, recommendations, and possible actions

5.3.1 Reputation
The single most important factor for recruiting students to engineering studies at NTNU is our reputation, which should be expected to be strongly correlated with the quality of our programmes of study and our research activities in a long time span. Our reputation relies on other factors as well, such as how the attractiveness of student life in the city of Trondheim is conceived among upper secondary school students. The advice of friends, parents, and other close relatives is likely to play a decisive role for students’ choice of school and field of study. From this perspective, the quality of our engineering education decades ago plays an important role for present recruitment, since parents are likely to base their advice on their own experience.

5.3.2 Organization
The central unit for recruitment and admissions seems to function well. In particular, it is our impression that it has found a reasonable balance between recruitment actions for engineering education and other fields. There is however a lack of contact with the academic leadership at Faculty level in the way it is managed at present. This situation could be remedied by letting the Executive Committee for Education at NTNU take on the responsibility of governing the NTNU policy for student recruitment.

5.3.3 Web pages
Surveys show that the web pages of NTNU are of great importance for recruiting new students. Young people are adept at navigating on the Internet and use the web frequently to acquire information. Information about courses, about future job opportunities and about facilities like computer labs and laboratories are questions the prospective students expect to find answers to through www.ntnu.no.

NTNU as a technical university is on display through our web pages. The outside world, including potential students, should expect our web pages to be based on the best technical tools available at any time. The programming behind the pages should be state of the art, so that it will be easier to transfer information to other devices, for instance cell phones. It is essential that our pages are easily accessible for disabled people and detectable by search engines such as “Google”.

A basic requirement is that the pages should be up-to-date; the information must therefore be corrected and updated regularly, and old pages with outdated information should never be accessible. The main focus for prospective students is to read about the programme of study to which they are applying and also to see available opportunities at NTNU. Thus there should be only one active page per programme of study which contains the desired, correct and the updated information. The possibility to change and make correction to these pages should be easy and flexible so that it is easy for the different programmes of study to maintain
its pages. There should also be automated systems for maintenance. There should also be ways of individualizing the pages while maintaining the overall similarity.

Prospective students will access our web pages mainly in the period from November to June. During this period it is important that the web pages are stable and that the information we want our future students to read is up-to-date.

The information about NTNU available in English, for instance about courses and individual programmes of study, should be much more extensive than it is at present.

### 5.3.4 Recruitment of female students

The table below shows the percentage of female students admitted to the different programmes of study. These numbers show that roughly one quarter of the students admitted to the programmes of engineering at NTNU are female. A few of the programmes have a majority of females among their students, while electrical engineering and ICT are fields that do not attract many female applicants.

<table>
<thead>
<tr>
<th>MSc in Engineering:</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Female</td>
<td>%</td>
</tr>
<tr>
<td>MASTER 5-YEAR:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Science:</td>
<td>102</td>
<td>10</td>
<td>9.8</td>
</tr>
<tr>
<td>Engineering Cybernetics:</td>
<td>83</td>
<td>6</td>
<td>7.2</td>
</tr>
<tr>
<td>Electronics</td>
<td>98</td>
<td>2</td>
<td>2.0</td>
</tr>
<tr>
<td>Communication Technology:</td>
<td>65</td>
<td>10</td>
<td>15.4</td>
</tr>
<tr>
<td>Industry Design:</td>
<td>21</td>
<td>8</td>
<td>38.1</td>
</tr>
<tr>
<td>Ind. Economy &amp; Tech.:</td>
<td>91</td>
<td>26</td>
<td>28.6</td>
</tr>
<tr>
<td>Earth Sci &amp; Petrol:</td>
<td>75</td>
<td>20</td>
<td>26.7</td>
</tr>
<tr>
<td>Phys/Math:</td>
<td>121</td>
<td>34</td>
<td>28.1</td>
</tr>
<tr>
<td>Mar. Tech.:</td>
<td>86</td>
<td>17</td>
<td>19.8</td>
</tr>
<tr>
<td>Chem. Engineering and Biology:</td>
<td>89</td>
<td>51</td>
<td>57.3</td>
</tr>
<tr>
<td>Civil and Environ. Eng.</td>
<td>168</td>
<td>58</td>
<td>34.5</td>
</tr>
<tr>
<td>Product Des. and Manufact.</td>
<td>118</td>
<td>25</td>
<td>21.2</td>
</tr>
<tr>
<td>Materials Sc. and Eng.</td>
<td>28</td>
<td>5</td>
<td>17.9</td>
</tr>
<tr>
<td>Energy and Environment</td>
<td>114</td>
<td>25</td>
<td>21.8</td>
</tr>
<tr>
<td>Engineering and ICT:</td>
<td>41</td>
<td>3</td>
<td>7.3</td>
</tr>
<tr>
<td>Nanotechnology</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>952</td>
<td>272</td>
<td>28.6</td>
</tr>
</tbody>
</table>

Measures have been taken to improve the situation, such as specific projects aimed at female students (“Jenter og data” [http://datajenter.ntnu.no/jd/jenterogdata.php](http://datajenter.ntnu.no/jd/jenterogdata.php) and “Piker med spiker” [http://org.ntnu.no/pikermedspiker/main.php](http://org.ntnu.no/pikermedspiker/main.php)) and “Jentedagen” – a one day welcome programme in late July for female students that have been admitted to ICT studies, sponsored by NTNU.

An increase of the number of female applicants without a corresponding loss of male applicants would imply a significant increase of the quality of students admitted to
5.3.5 Alumni
Alumni can be used as a positive factor in recruitment of students in several indirect ways, and there should be a well-thought link between the NTNU recruitment policy and the alumni organization. With the help of selected alumni we could show the rich variety of interesting job opportunities available for candidates with a degree in engineering. Alumni may serve as role models for potential students, and we believe that in particular young female alumni (below 35) should be used actively as role models for girls in secondary school and upper secondary school, cf. the results of the ROSE project. NTNU should present alumni in their recruitment information. Such presentations should show what the selected alumni work with and how they use their education in their daily work. Interviews with potential students, as well as with first- and second-year students show that this information is important to some student groups when they make decisions about their education, and the information is also important in providing a motivation and “goal” for younger students.

5.3.6 International aspects
Ongoing and planned actions to recruit students to the international MSc programmes at NTNU are described in Section 5.2.2. In addition, we would like to address the following issues of principle importance:

- The current international recruitment policy concerns mainly admissions to MSc programmes (2 years). Currently it seems unrealistic to admit students to the integrated engineering education (5 years) without sufficient knowledge of Norwegian as, at present, teaching during the first 3 years of study is in Norwegian. However, our language policy may very well change in the foreseeable future.
- The most efficient and desirable way to increase international recruitment is to establish agreements about joint/double degrees and common quality management principles for educational programmes with attractive foreign partners such as IDEA League and Nordic Five Tech. A very essential difficulty in this connection is the difference in national policies regarding tuition fees. At present, Norwegian regulations only allow public higher education institutions to take fees for further and continuing education activities.
- Each separate programme of study should keep in mind that possibilities for spending time abroad may be an important factor for prospective students when making their choice about education. Well thought presentations of whatever exchange agreements, possibilities for joint degrees etc. that are available, should be on display for prospective students.

5.3.7 Interaction with industry
In Section 5.4 we have collected a number of tables regarding the recruitment to the engineering education at NTNU during 2003-2006. The reader may notice a positive trend for the programme in civil engineering during these four years in terms of number of applicants and admission requirements. In fact, numbers show that this positive trend started in 1999; at the same time, a strong alliance between this particular programme of study and a consortium of civil engineering firms was established, called “Næringslivsringen”. This industry forum is made up of some 45 companies and aims at increased recruitment of students as well as interaction with NTNU to make a best possible education. Civil engineering firms support the
industry forum financially, both for recruitment campaigns and for supporting students during their studies. All students within this programme are offered relevant summer jobs.

Approximately half of the programmes of study have such strong alliances between their particular programme of study and a consortium of engineering firms. For programmes with a similar close link to a specific segment of the engineering industry, similar collaboration forums should be encouraged. One may also consider the possibility of establishing an additional alliance with industry on a broader scale, serving several programmes within the engineering education, as major companies typically will be interested in recruiting students from several different programmes. The Cooperative Forum “Samarbeidsforum” at Faculty of Natural Science and Technology (involving 18 companies) is an initiative in this direction, aiming at increased recruitment to the fields of natural sciences and technology in general and in particular to the programmes of study in that Faculty.

5.3.8 Admission examinations
The ROSE project indicates that there are inherent limitations of recruitment measures in a well-developed, high standard of living country like Norway: too few young people are interested in careers in science and technology. This is a long-term and deeply embedded trend that one cannot expect to turn around in the short or medium term.

NTNU may consider launching a trial project with an admission exam as an alternative for those who cannot qualify based on upper secondary school grades. Admission tests are used in many countries, and one of these may therefore be copied and possibly modified for such a purpose. A possibility could be that some of the engineering programmes (those which have unsatisfactory patronage today) at NTNU set aside – say – 5 to 10 per cent of their yearly admissions quota for students that pass an admission exam.

The admission exam should not be an easy alternative way into academic engineering education. The achievement level to be admitted via such a test must be so strict that the average mathematics and physics skills of the candidate should be at least at the corresponding skills level of the average (and not the weakest) students admitted today via upper secondary school grades. To ensure this, the admission exam should be tested beforehand for calibration purposes. One may recruit a satisfactory-sized group of volunteer first-year NTNU students and let them do the test. Calibration may then be carried out by deciding the required future minimum achievement for being admitted through this exam, by comparing the test group's results to their upper secondary school grades.

5.3.9 Role of NTNU in the effort to increase the interest in science and technology
In addition to actions that are expected to have direct impact on recruitment to engineering education at NTNU, NTNU should also be engaged broadly in the effort to increase the general interest in science and technology among young people supporting the strategy and action plan of the Ministry of Education and Research initiated in 2006. The results of the ROSE project indicate the profundity and the global nature of the problem, and one should therefore not expect any easy solutions. Over the last decade or so, we have however witnessed an increased awareness of the situation among politicians and industrial leaders. There is a fear that in the foreseeable future there will be a serious lack of engineers and scientists in Norway. At present, a number of initiatives are taken nationally and locally to
motivate young people for a career in engineering or science; a working group under the Ministry of Education and Research aims at coordinating such actions.

Besides the many actions mentioned above (see Section 5.2.1 on national recruitment), NTNU should contribute decisively in the following areas (some initiatives have already been taken):

- Technology has now been established as a separate subject in upper secondary school. NTNU should engage actively in shaping this subject and contribute to providing teaching material, both in terms of written texts and interactive tools. A separate web page should be established.

- Continuing education and professional development for teachers is essential for whether the new subject of technology will be successful. NTNU should develop adequate courses in this subject. It is also important to shape new courses in traditional fields as a response to the new school reform “Kunnskapsloftet” (2006). Within mathematics a quite popular Internet-based education programme for teachers exists; it is more challenging to establish similar courses in experimental fields.

- The Ministry of Education and Research has proposed a new kind of teaching position: Adjunct upper secondary school teacher. The idea is that some professional, e.g. an engineer, has say a 20% teaching position in upper secondary school. NTNU should be active in shaping the requirements to such adjunct teachers and also in providing them with the necessary skills in didactics/pedagogy.

- There are professional advisers at every upper secondary school who advise upper secondary school students on their choice of curriculum and further career. Such advisers clearly play a key role. As a supplement to their traditional training, we propose that NTNU host separate conferences for upper secondary school advisers in order to make them fully aware of the range of possibilities for careers in science and engineering, as well as the need for engineers in modern society.
5.4 Some Key Data

Table 16: Number of applicants to NTNU through the National Admission Service (Samordna oppg) – total number of applicants and primary applicants

<table>
<thead>
<tr>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MASTER 5-YEAR:</strong></td>
<td><strong>Totally</strong></td>
<td><strong>Prim:</strong></td>
<td><strong>Totally</strong></td>
</tr>
<tr>
<td>Computer Science</td>
<td>1208</td>
<td>328</td>
<td>873</td>
</tr>
<tr>
<td>Engineering Cybernetics</td>
<td>1154</td>
<td>216</td>
<td>797</td>
</tr>
<tr>
<td>Electronics</td>
<td>1108</td>
<td>188</td>
<td>912</td>
</tr>
<tr>
<td>Communication Technology</td>
<td>1074</td>
<td>144</td>
<td>771</td>
</tr>
<tr>
<td><strong>Sum ICT-related:</strong></td>
<td>4544</td>
<td>876</td>
<td>3353</td>
</tr>
<tr>
<td>Industrial Design</td>
<td>907</td>
<td>167</td>
<td>838</td>
</tr>
<tr>
<td>Ind. Economy &amp; Tech.Man.</td>
<td>1512</td>
<td>522</td>
<td>1329</td>
</tr>
<tr>
<td>Earth Science &amp; Petroleum</td>
<td>1016</td>
<td>119</td>
<td>821</td>
</tr>
<tr>
<td>Phys/Math</td>
<td>1054</td>
<td>187</td>
<td>850</td>
</tr>
<tr>
<td>Marin Technology</td>
<td>871</td>
<td>127</td>
<td>887</td>
</tr>
<tr>
<td>Chem.Engineering and Biology</td>
<td>748</td>
<td>139</td>
<td>628</td>
</tr>
<tr>
<td>Civil and Env. Eng.</td>
<td>1510</td>
<td>322</td>
<td>1505</td>
</tr>
<tr>
<td>Product Des. and Manufact.</td>
<td>1191</td>
<td>184</td>
<td>1083</td>
</tr>
<tr>
<td>Materials Sc. and Eng.</td>
<td>856</td>
<td>56</td>
<td>696</td>
</tr>
<tr>
<td>Energy and Environment</td>
<td>1281</td>
<td>164</td>
<td>1043</td>
</tr>
<tr>
<td>Engineering and ICT</td>
<td>782</td>
<td>88</td>
<td>460</td>
</tr>
<tr>
<td>Nanotechnology</td>
<td>1429</td>
<td>265</td>
<td></td>
</tr>
<tr>
<td><strong>Sum technology-related:</strong></td>
<td>11725</td>
<td>2075</td>
<td>10140</td>
</tr>
<tr>
<td><strong>Sum MSc in Engineering</strong></td>
<td>16272</td>
<td>2951</td>
<td>13493</td>
</tr>
</tbody>
</table>

Table 17: Number of places at the different programmes of study 2003-2006 (incl. places in 2 year MSc programmes for students with a bachelor of engineering. Source: DBH

<table>
<thead>
<tr>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MASTER 5-YEAR:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Science</td>
<td>165</td>
<td>155</td>
<td>145</td>
</tr>
<tr>
<td>Engineering Cybernetics</td>
<td>105</td>
<td>105</td>
<td>105</td>
</tr>
<tr>
<td>Electronics</td>
<td>105</td>
<td>105</td>
<td>105</td>
</tr>
<tr>
<td>Communication Technology</td>
<td>95</td>
<td>90</td>
<td>75</td>
</tr>
<tr>
<td>Industrial Design</td>
<td>20</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Ind. Economy &amp; Tech.</td>
<td>110</td>
<td>110</td>
<td>100</td>
</tr>
<tr>
<td>Earth Science &amp; Petrol</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Phys/Math.</td>
<td>120</td>
<td>110</td>
<td>100</td>
</tr>
<tr>
<td>Marin Tech</td>
<td>85</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Chem. Engineering and Biology</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Civil and Environ. Engineering.</td>
<td>165</td>
<td>185</td>
<td>190</td>
</tr>
<tr>
<td>Product Des. and Manuf.</td>
<td>125</td>
<td>130</td>
<td>130</td>
</tr>
<tr>
<td>Materials Sc. and Engineering.</td>
<td>35</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Energy and Environment</td>
<td>115</td>
<td>115</td>
<td>115</td>
</tr>
<tr>
<td>Engineering and ICT</td>
<td>60</td>
<td>45</td>
<td>55</td>
</tr>
<tr>
<td>Nanotechnology</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>
Table 18: Number of study places, students accepting and students who actually have met 2003-2006. Source: DBH

<table>
<thead>
<tr>
<th>Study places offered</th>
<th>Students accepting</th>
<th>Students met</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Science</td>
<td>263</td>
<td>160</td>
</tr>
<tr>
<td>Engineering Cybernetics</td>
<td>154</td>
<td>145</td>
</tr>
<tr>
<td>Electronics</td>
<td>183</td>
<td>151</td>
</tr>
<tr>
<td>Communication Technology</td>
<td>162</td>
<td>112</td>
</tr>
<tr>
<td><strong>Sum ICT-related:</strong></td>
<td>762</td>
<td>568</td>
</tr>
<tr>
<td>Industrial design</td>
<td>33</td>
<td>30</td>
</tr>
<tr>
<td>Eng. Economy &amp; Tech.</td>
<td>165</td>
<td>155</td>
</tr>
<tr>
<td>Earth Science &amp; Petrol</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>Phys/Math</td>
<td>215</td>
<td>181</td>
</tr>
<tr>
<td>Marin Tech</td>
<td>134</td>
<td>140</td>
</tr>
<tr>
<td>Chem. Engineering and Biology</td>
<td>139</td>
<td>125</td>
</tr>
<tr>
<td>Civil and Environ. Engineering</td>
<td>264</td>
<td>257</td>
</tr>
<tr>
<td>Product Des. and Manuf.</td>
<td>204</td>
<td>191</td>
</tr>
<tr>
<td>Materials Sc. and Eng.</td>
<td>42</td>
<td>55</td>
</tr>
<tr>
<td>Energy and Environment</td>
<td>186</td>
<td>174</td>
</tr>
<tr>
<td>Engineering and ICT</td>
<td>94</td>
<td>56</td>
</tr>
<tr>
<td>Nanotechnology</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td><strong>Sum technology-related:</strong></td>
<td>1601</td>
<td>1489</td>
</tr>
<tr>
<td>Sum MSc in Engineering:</td>
<td>2363</td>
<td>2057</td>
</tr>
</tbody>
</table>

Table 19: Admission point limitations for admittance to NTNU - based on main admittance. Source: Universities and Colleges Admission Service

<table>
<thead>
<tr>
<th><strong>MASTER 5-YEAR:</strong></th>
<th>Ord.</th>
<th>Prim</th>
<th>BE</th>
<th>Ord.</th>
<th>Prim</th>
<th>BE</th>
<th>Ord.</th>
<th>Prim</th>
<th>BE</th>
<th>Ord.</th>
<th>Prim</th>
<th>BE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Science</td>
<td>48.7</td>
<td>51.3</td>
<td>3.6</td>
<td>45.9</td>
<td>47.0</td>
<td>2.5</td>
<td>46.8</td>
<td>50.0</td>
<td>2.5</td>
<td>50.8</td>
<td>55.5</td>
<td>2.8</td>
</tr>
<tr>
<td>Eng. Cybernetics</td>
<td>55.5</td>
<td>55.5</td>
<td>3.5</td>
<td>45.5</td>
<td>53.8</td>
<td>2.5</td>
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<td>53.7</td>
<td>2.5</td>
<td>51.3</td>
<td>54.5</td>
<td>3.8</td>
</tr>
<tr>
<td>Electronics</td>
<td>47.9</td>
<td>51.3</td>
<td>2.6</td>
<td>43.5</td>
<td>48.0</td>
<td>2.5</td>
<td>50.0</td>
<td>52.3</td>
<td>2.5</td>
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<td>60.9</td>
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<td>53.4</td>
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<td>64.7</td>
<td>5.6</td>
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</table>

Ordinary = All exams and additional point included (age, additional education, experience etc)
Prim = only exams from upper secondary school
BE = candidates from Norwegian University Colleges (Bachelor of Engineering). A grade point average of C or better is required for these bachelor's students to be admitted to the latter part of the integrated MSc Engineering programme at NTNU.
Table 20: Admittance of Bachelor of engineering candidates from the University Colleges to a 2-year MSc in Engineering at NTNU. Source: NTNU

<table>
<thead>
<tr>
<th>Programme</th>
<th>Study places (frame number)</th>
<th>No. of applicants</th>
<th>No. of places offered</th>
<th>No. of students accepting</th>
<th>No. of students met</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Sc.</td>
<td>40</td>
<td>33</td>
<td>146</td>
<td>100</td>
<td>60</td>
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<tr>
<td>Eng. Cybernetics</td>
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<td>40</td>
<td>98</td>
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<td>Electronics</td>
<td>25</td>
<td>13</td>
<td>146</td>
<td>79</td>
<td>34</td>
</tr>
<tr>
<td>CommTechn</td>
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<td>7</td>
<td>119</td>
<td>64</td>
<td>18</td>
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<tr>
<td><strong>Sum ICT:</strong></td>
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<td>93</td>
<td>509</td>
<td>342</td>
<td>140</td>
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<td>5</td>
<td>48</td>
<td>53</td>
<td>8</td>
</tr>
<tr>
<td>Ind. Econ&amp;tech</td>
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<td>6</td>
<td>124</td>
<td>67</td>
<td>8</td>
</tr>
<tr>
<td>Earth Science &amp; Petrol</td>
<td>5</td>
<td>5</td>
<td>51</td>
<td>40</td>
<td>3</td>
</tr>
<tr>
<td>Marin Tech.</td>
<td>10</td>
<td>10</td>
<td>58</td>
<td>74</td>
<td>7</td>
</tr>
<tr>
<td>Chem. &amp; bio.</td>
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<td>10</td>
<td>34</td>
<td>44</td>
<td>12</td>
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<td>Civil and Environ. Engineering</td>
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<td>76</td>
<td>137</td>
<td>157</td>
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<td>15</td>
<td>82</td>
<td>79</td>
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</tr>
<tr>
<td>Materials Science</td>
<td>5</td>
<td>2</td>
<td>50</td>
<td>57</td>
<td>5</td>
</tr>
<tr>
<td>Energy and Env.</td>
<td>15</td>
<td>**</td>
<td>78</td>
<td>**</td>
<td>22</td>
</tr>
<tr>
<td><strong>Sum techn</strong></td>
<td>115</td>
<td>124</td>
<td>662</td>
<td>571</td>
<td>145</td>
</tr>
<tr>
<td>TOTAL SUM:</td>
<td>205</td>
<td>217</td>
<td>1171</td>
<td>913</td>
<td>285</td>
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** Energy and environment ended as a 2-year master’s programme in the autumn 2006. It was replaced by an international master’s programme in Electric Power Engineering.


<table>
<thead>
<tr>
<th>Total number</th>
<th>Østlandet</th>
<th>Trøndelag</th>
<th>Vestlandet</th>
<th>Nord-Norge</th>
<th>Sørlandet</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>131272</td>
<td>25441</td>
<td>77529</td>
<td>27964</td>
<td>17187</td>
<td>279393</td>
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<td>126793</td>
<td>24793</td>
<td>76746</td>
<td>27838</td>
<td>17344</td>
<td>275514</td>
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<td>24347</td>
<td>76064</td>
<td>27903</td>
<td>17371</td>
<td>272726</td>
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<td>2004</td>
<td>126233</td>
<td>24111</td>
<td>76247</td>
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<td>17568</td>
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<table>
<thead>
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<th>In percent</th>
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<th>Vestlandet</th>
<th>Nord-Norge</th>
<th>Sørlandet</th>
<th>Sum</th>
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<tbody>
<tr>
<td>2007</td>
<td>47.00 %</td>
<td>9.10 %</td>
<td>27.70 %</td>
<td>10.00 %</td>
<td>6.20 %</td>
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<td>2006</td>
<td>46.70 %</td>
<td>9.00 %</td>
<td>27.90 %</td>
<td>10.10 %</td>
<td>6.30 %</td>
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<tr>
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<tr>
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<td>46.40 %</td>
<td>8.90 %</td>
<td>28.00 %</td>
<td>10.20 %</td>
<td>6.50 %</td>
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Table 22: The regional background of the students admitted to the MSc in engineering education 2004-2007. Source: Statistics Norway

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<tr>
<th>Total number</th>
<th>Østlandet</th>
<th>Trøndelag</th>
<th>Vestlandet</th>
<th>Nord Norge</th>
<th>Sørlandet</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>666</td>
<td>180</td>
<td>348</td>
<td>97</td>
<td>47</td>
<td>1338</td>
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<td>2006</td>
<td>641</td>
<td>164</td>
<td>370</td>
<td>109</td>
<td>67</td>
<td>1351</td>
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<tr>
<td>2005</td>
<td>585</td>
<td>177</td>
<td>335</td>
<td>84</td>
<td>77</td>
<td>1258</td>
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<td>603</td>
<td>181</td>
<td>377</td>
<td>76</td>
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<th>Vestlandet</th>
<th>Nord Norge</th>
<th>Sørlandet</th>
<th>Sum</th>
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</thead>
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<tr>
<td>2007</td>
<td>49.8 %</td>
<td>13.5 %</td>
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<td>7.2 %</td>
<td>3.5 %</td>
<td>100 %</td>
</tr>
<tr>
<td>2006</td>
<td>47.4 %</td>
<td>12.1 %</td>
<td>27.4 %</td>
<td>8.1 %</td>
<td>5.0 %</td>
<td>100 %</td>
</tr>
<tr>
<td>2005</td>
<td>46.5 %</td>
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<td>26.6 %</td>
<td>6.7 %</td>
<td>6.1 %</td>
<td>100 %</td>
</tr>
<tr>
<td>2004</td>
<td>46.4 %</td>
<td>13.9 %</td>
<td>29.0 %</td>
<td>5.9 %</td>
<td>4.8 %</td>
<td>100 %</td>
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Table 23: Drop-out analysis – 5 year integrated engineering education (2004 admission)

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<th>Programme of Study</th>
<th>Status, category</th>
<th>Number</th>
<th>Per cent</th>
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<td>140</td>
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<td>2</td>
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<td></td>
<td>Dropped out MSc programme</td>
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<td>15.5 %</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>168</td>
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</tr>
<tr>
<td>Computer Science</td>
<td>Continue, same programme</td>
<td>69</td>
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</tr>
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<td></td>
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<td>5</td>
<td>4.9 %</td>
</tr>
<tr>
<td></td>
<td>Dropped out MSc programme</td>
<td>28</td>
<td>27.5 %</td>
</tr>
<tr>
<td></td>
<td>Total</td>
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<td>Electronics</td>
<td>Continue, same programme</td>
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<td>Continue, another MSc programme</td>
<td>8</td>
<td>8.1 %</td>
</tr>
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<td>Dropped out MSc programme</td>
<td>29</td>
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<td>4.7 %</td>
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<td>----------------------------</td>
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<td>----------</td>
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<tr>
<td><strong>Materials Science and Engineering</strong></td>
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<td>17.9 %</td>
</tr>
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<td>100.0 %</td>
</tr>
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</tr>
<tr>
<td></td>
<td>Continue, another MSc programme</td>
<td>15</td>
<td>12.7 %</td>
</tr>
<tr>
<td></td>
<td>Dropped out MSc programme</td>
<td>26</td>
<td>22.0 %</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>118</td>
<td>100.0 %</td>
</tr>
<tr>
<td><strong>Engineering Cybernetics</strong></td>
<td>Continue, same programme</td>
<td>54</td>
<td>65.1 %</td>
</tr>
<tr>
<td></td>
<td>Continue, another MSc programme</td>
<td>10</td>
<td>12.0 %</td>
</tr>
<tr>
<td></td>
<td>Dropped out MSc programme</td>
<td>19</td>
<td>22.9 %</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>83</td>
<td>100.0 %</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>Continue, same programme</td>
<td>927</td>
<td>71.3 %</td>
</tr>
<tr>
<td></td>
<td>Continue, another MSc programme</td>
<td>102</td>
<td>7.8 %</td>
</tr>
<tr>
<td></td>
<td>Dropped out MSc programme</td>
<td>271</td>
<td>20.8 %</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>1300</td>
<td>100.0 %</td>
</tr>
</tbody>
</table>
This is NTNU – Norwegian University of Science and Technology

NTNU is a university with a broad academic scope that has its main focus on technology and the natural sciences. The university has about 20,000 students and 4,800 staff. NTNU has been given the national responsibility for graduate engineering education in Norway and offers an extensive range of subjects in the natural sciences, technology, the humanities, aesthetic studies, health studies, the social sciences, and financial and economic disciplines. NTNU offers education in the professions: technology, medicine, psychology, architecture, fine art, music, pictorial art, architecture, and teacher education.

NTNU’s research has an international focus and can be characterized by being at the leading edge in specific areas of technology, broad disciplinary scope and the interdisciplinary approach. NTNU has selected six thematic interdisciplinary strategic areas that address the key societal challenges where it is especially qualified to make a contribution:

- Energy and petroleum, resources and environment
- Globalization
- Information and communication technology
- Medical technology
- Marine and maritime research
- Materials technology

NTNU has extensive strategic cooperation with SINTEF.

Our role

NTNU’s main tasks are to

- **develop and administer knowledge** by maintaining, creating and disseminating knowledge in interaction with society
- **develop our graduates’ expertise** by providing high quality research-based education that has relevance for both the individual and society
- **renew society** and contribute to value creation and better welfare standards – regionally, nationally and globally

Our value statement

NTNU’s value statement is expressed in its strategic plan “Creative, constructive and critical” from 2001.

NTNU is based on the fundamental democratic idea of the university as a critical and independent institution. NTNU’s activities are to be characterized by openness and high ethical standards.

NTNU is to have a working and learning environment that is to be compatible with creative interaction, constructive problem-solving and critical assessment. NTNU is to encourage contributions from its students and staff, promote tolerance irrespective of sex, outlook on life and culture.

NTNU is to search for innovative and sustainable solutions to domestic and global challenges.

Our vision: “NTNU Internationally Outstanding 2020”

Research and higher education are global activities that can be characterized by increased competition for human and material resources. In such a situation, NTNU has to be continuously engaged in measures to enhance the quality of all activities. NTNU is to have the ambition of being one of the outstanding universities in Europe.
Our vision is that by 2020 NTNU is to be internationally recognized as an outstanding university. Generally accepted criteria, evaluations and assessments are to document that

- NTNU is among the international leaders in our selected strategic areas
- NTNU is among the ten leading technological and scientific universities in Europe
- NTNU is among the top 1% of universities in the world that offer broad academic scope

Our challenges

For Norway it is vital to have strong, internationally focused education and research environments. Education and research are competitive factors in any country that is dependent on producing knowledge-intensive products, processes and services. The international success of Norway is dependent on having quality universities with high academic standing. NTNU must therefore

- **be characterized by academic and scientific quality and relevance** by developing staff competencies and creating the infrastructure and conditions needed to develop leading research groups that meet the innovative requirements of society.
- **recruit outstanding students and researchers** by having an attractive range of academic programmes and creating competitive working conditions and learning environment
- **recruit more females to academic positions**, this is especially important in natural science and technology
- **increase our visibility** by dissemination and marketing of NTNU’s strong points nationally and internationally
- **be a dynamic organization** by working towards our priorities and having effective processes and systems to support our core activities
- **maintain and develop the university as a distinct democratic institution** by enabling students and staff to have freedom of expression and encourage active participation
- **generate sufficient investment and operational income** by making our expertise visible and engagement in activities together with the authorities, the Research Council of Norway and industry – regionally, nationally and internationally

Strategic objectives

Research

Research at NTNU is to have recognized international standing in all disciplines. Selected strong point areas are to be at the international leading edge. Research at NTNU is to be characterized by relevance, top-level expertise and interdisciplinary cooperation. The quality of our research is to be further enhanced by actively seeking cooperation and alliances with prominent scientific groups nationally and internationally.

<table>
<thead>
<tr>
<th>Objectives 2010</th>
<th>Objectives 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Publications</strong></td>
<td>25% of the national publication points (index 2005); 25% of all publications are at level 2.</td>
</tr>
<tr>
<td><strong>PhDs</strong></td>
<td>350 PhD degrees awarded</td>
</tr>
</tbody>
</table>
**External funding**  
35 % increase in externally funded research; 100 % increase in EU-funded research (index 2005)  
International funding for projects in all selected strategic and strong point areas

**Interdisciplinary measures**  
50 % more publications with authors from more than one faculty; 15 % of PhD candidates have supervisors from at least two faculties  
Interdisciplinary cooperation that is comparable with the 20 best universities in Europe

**Strategies**
- Establish clear lines of academic management and priorities, and allocate more continuous time for research
- Use and develop our laboratories, work in cooperation with SINTEF and St. Olavs University Hospital
- Increase the mobility of researchers and seek cooperation with prominent research groups
- Stimulate increased interdisciplinary cooperation in research
- Recruit outstanding post docs and doctoral candidates and strengthen measures to follow them up

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**Education**

NTNU’s programmes of study and continuing and further education are to be relevant for society and there is to be a demand for our graduates in working life. The education is to be conducted in a learning environment with high academic and pedagogical quality that is characterized by interdisciplinary diversity. NTNU is to promote interdisciplinary measures and merge theory with practice. NTNU is to have an international focus and be leading in technological and natural science education. Master’s and doctoral degrees are to be given priority. Continuing and further education is to be strengthened.

<table>
<thead>
<tr>
<th>Student recruitment</th>
<th>Objectives 2010</th>
<th>Objectives 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At least 2.5 primary applicants per place on average; &gt;10 % international students at master's level</td>
<td>Europe’s most attractive university in selected programmes of study, continuing and further education; competition for all places at NTNU</td>
</tr>
<tr>
<td>Joint programmes of study/degrees with recognized international universities</td>
<td>At least 3 joint programmes of study/degrees (Master’s/PhD) with recognized international universities per faculty</td>
<td>Joint programmes of study/degrees (Master’s/PhD) with universities that are ranked among the 20 best in Europe</td>
</tr>
<tr>
<td>Student contentment</td>
<td>8 of 10 are satisfied or very satisfied on relevant scales in Bachelor’s/Master’s/PhD education and in continuing and further education</td>
<td>Ranked among Europe’s 20 best according to recognized measures</td>
</tr>
<tr>
<td>Work market contentment</td>
<td>8 of 10 are satisfied or very satisfied on relevant scales in Bachelor’s/Master’s/PhD education and in continuing and further education</td>
<td>Ranked among Europe’s 20 best according to recognized measures</td>
</tr>
</tbody>
</table>

**Strategies**
- Strengthen recruitment and network building with other educational institutions, industry and society
- Develop more education given in English especially at Master’s and PhD levels and implement measures to market this
- Create an eminent learning environment in close cooperation with student organizations and the Student Welfare Organization
- Coordinate and develop a comprehensive learning environment for quality in university education
- Develop structures that further interdisciplinary teaching and cooperation in supervision
**Dissemination**

NTNU is to be the leading university in Norway in terms of broad dissemination to the general public. It is to have specific responsibility for increasing knowledge about and interest in natural science and technology in society. NTNU’s students and staff are to be stimulated to actively participate in the wider transfer of knowledge. Dissemination of art and knowledge are to contribute to strengthening NTNU’s standing and visibility.

<table>
<thead>
<tr>
<th>Dissemination to the general public</th>
<th>Objectives 2010</th>
<th>Objectives 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20 % more publications/measure (index 2005)</td>
<td>Highest level of publications/ general dissemination measures per member of the tenured staff in Norway</td>
</tr>
<tr>
<td>Media coverage</td>
<td>Daily mention in national press/media</td>
<td>Regular mention in international media</td>
</tr>
<tr>
<td>Recognition and standing index</td>
<td>High level of recognition/ good standing among selected target groups</td>
<td>High level of recognition/ good standing among selected target groups internationally</td>
</tr>
</tbody>
</table>

**Strategies**
- Strengthen support systems for media training and dissemination skills
- Develop existing and new channels for dissemination, including international internet portals at NTNU
- Use the know-how and collections found at the Museum of Natural History and Archaeology (NTNU) to simulate interest in natural science and technology
- Profile NTNU’s artistic disciplines in dissemination and international brand building
- Active participation in the social debate to influence the agenda for research, education and industrial policy

**Innovation**

NTNU and SINTEF are to be national leaders in contributing to research-based spin-off companies and revitalization of the public and private sectors. In selected areas, NTNU is to be among the international leaders. NTNU’s students are to be encouraged to apply their knowledge to innovative commercial activities.

<table>
<thead>
<tr>
<th>Innovation and commercialization</th>
<th>Objectives 2010</th>
<th>Objectives 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At least 20 spin-offs formed (companies or licensing agreements)</td>
<td>Among Europe’s 10 leading universities in research-driven innovation</td>
</tr>
<tr>
<td>R&amp;D contracts with user involvement</td>
<td>50 % increase in the contracted amounts for new R&amp;D projects with user involvement (index 2005)</td>
<td>Among Europe’s 10 leading universities measured in R&amp;D projects per member of the tenured staff</td>
</tr>
<tr>
<td>Student participation in innovation</td>
<td>10 companies formed; 50 % more student projects in companies (index 2005)</td>
<td>Among Europe’s 10 leading universities for student participation in innovation</td>
</tr>
</tbody>
</table>

**Strategies**
- Introduce duty relief arrangements for staff involved in innovation activities
- Integrate entrepreneurship in more programmes of study
- Develop a comprehensive and effective support apparatus for innovation, technology transfer and commercialization
- Engage more adjunct professors from the public and private sectors
**Organization and resources**

NTNU is to have the physical framework conditions and organizational culture that will help students and staff to develop their competencies and enable NTNU to meet its objectives. NTNU is to obtain adequate resources for its core activities. It is to have modern, competitive laboratories and infrastructure, and provide effective administrative services for its students and staff.

<table>
<thead>
<tr>
<th>Work environment and staff contentment</th>
<th>Objectives 2010</th>
<th>Objectives 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work environment surveys: 8 of 10 are satisfied or very satisfied on relevant scales</td>
<td>Ranked among Europe’s best based on recognized measures</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percentage of females with tenure</th>
<th>Objectives 2010</th>
<th>Objectives 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least 30 % on average at NTNU; better balance between the disciplines</td>
<td>Genuine equal opportunities in all disciplines</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percentage of newly hired staff with a background from another institution</th>
<th>Objectives 2010</th>
<th>Objectives 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least 50 %; at least half of these come from internationally outstanding institutions</td>
<td>Internationally attractive workplace; satisfactory number of external applicants for all positions</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Financial resources</th>
<th>Objectives 2010</th>
<th>Objectives 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 % increase in NTNU’s total resources (index 2005)</td>
<td>Resources per member of the tenured staff are above the European average</td>
<td></td>
</tr>
</tbody>
</table>

**Strategies**

- Develop a comprehensive personnel policy for NTNU that places weight on the development of skills and competencies and the organizational culture
- Motivate staff performance and cooperation by wider use of incentives
- Have a recruitment policy that is based on strategic personnel plans, particularly measures to strengthen the career opportunities for female staff
- Introduce unitary management and strengthen the interaction between organizational levels
- Compile an active policy for campus development and property management that supports the main objectives of NTNU
- Implement measures that make NTNU’s expertise more visible to the authorities, the Research Council of Norway, industry and the community at large; market this expertise to these groups
Engineering Education in the 21st Century

The Curriculum Development Committee for The Sivilingeniør Degree at The Norwegian Institute of Technology

English Summary of NTH Report 1993-8
Introduction
It is more than twenty years since The Norwegian Institute of Technology (NTH) had a total revision of the Sivilingeniør Degree programme. However, there has been a detailed review of the first part of the programme.

It is a fact that during the same period of time tremendous development has taken place, both in technology and in society. Therefore, the board of directors at NTH appointed The Curriculum Development Committee for the Sivilingeniør Degree, with the mandate to review the quality, the structure and the content of the Sivilingeniør Degree programme at NTH.

Main recommendation
The Curriculum Development Committee for the Sivilingeniør Degree at The Norwegian Institute of Technology (NTH) states that NTH has the national responsibility for the sivilingeniør degree. When the quality, content and international level of the programme are considered in terms of NTH’s responsibility, it is imperative to extend the nominal length of the degree programme. The committee proposes that this MSc-level degree is extended into an integrated five-year programme.

The Curriculum Development Committee’s main recommendation is that:
• The sivilingeniør degree programme to be extended to five years

Background
The first chapter of this report puts this work in context. It is clear that we are nearing the end of a century marked by technological development which radically and irreversibly has changed our way of life. The changes in our community, the character of the engineering sciences and the educational system have been, and are still, significant. In addition, the amount of technological knowledge has increased formidably. All these factors have placed new demands on the sivilingeniør degree programme.

The Sivilingeniør degree programme at NTH is acknowledged to be technically sound, effective, and targeted. It provides a professional education within a clearly defined framework. Students at NTH acquire knowledge and the skill to work with many assignments simultaneously. The pressures of studying and examinations train students to quickly assimilate new problems. The social environment is good, with integration in student classes as a key characteristic.

However, the pressure of the degree programme is considerable. There are extensive syllabuses and too little time for in-depth study, creativity and the opportunity to show initiative. There is also restricted subject integration. In the first part of the studies there are few applied subjects.

Comparisons with leading technological universities abroad show that sivilingeniør students at NTH have the shortest study time among their peers. They have the shortest diploma, most students per teacher, most written problem solving and least laboratory work.
In real terms, State contributions to NTH have been reduced in recent years, and most of the budget is earmarked for fixed expenses. Contributions per student have been reduced considerably in the past decade. The resources required for each graduate are lower than in comparable technological universities abroad.

Higher technological education in Norway

Chapter two considers higher technological education in Norway, with NTH as the natural national focus. The Colleges of Engineering and NTH have their own separate approaches to professional education. The fundamental difference is that NTH gives a technological, scientific education, which stresses the ability to solve new, complicated problems, see technology in a broader perspective and help to develop it. Colleges of Engineering give a sound technological education, teach the technological state of the art, current methods and the skills required to solve on-going tasks. All technological education in Norway must be evaluated as a whole, in order to increase quality in relation to the concept of the Norwegian educational network.

Society is developing quickly and NTH wants to be involved in this development and take its share of the responsibility. NTH has a regional location, national responsibility and is part of the international arena. Because of this, NTH must match the best technological universities abroad in terms of quality.

Education at NTH is to give students ethical values and attitudes which help them understand the role of engineering in a comprehensive social and environmental perspective. Students are to receive good basic scientific knowledge, broad engineering know-how, in-depth specialization in a restricted field of research, training in creative work and the analysis of complex tasks, stimulation to generate innovation and wealth creation as well as training in leadership and the motivation of others. The Committee would like to see that the positive aspects of the education provided at NTH are retained.

The Curriculum Development Committee recommends that:

- NTH is to retain national responsibility and its leading position within higher technological education.
- The overall objective is a degree programme that gives students knowledge, skills and attitudes, and relevant professional competence.
- The degree programme is to be at an internationally-accepted Master of Science level.
- NTH is to take the initiative to establish a National council for technological education.

Organization of the sivilingeniør degree
Chapter three deals with the organization of the sivilingeniør degree. There has always been considerable interest in taking a degree at NTH. In 1993, 6650 applied for the 1400 places in the sivilingeniør degree programmes. The elective subjects available in the upper secondary school, must not undermine recruitment to higher technological education. NTH must work together with the State authorities and the engineering education council to reach the optimal solution regarding admission from Colleges of Engineering. The Committee believes that the recommended curriculum plan will motivate female applicants more than the present one.

The Curriculum Development Committee recommends that:

- Admission directly from upper secondary school will still be the primary source of applicants.
- Applicants from Colleges of Engineering are to enter NTH in the third year after completing two years at college.
- The percentage of female students is to increase by 1% a year over the next decade.

Larger subjects and a uniform size of the subjects should improve routines for work and give students the opportunity to cooperate across disciplinary and organizational boundaries. All students will have a common set of basic subjects in mathematics and science, a subject in information- and data processing, and non-technological subjects in order to provide a common platform for interdisciplinary cooperation.

The basic subjects provide a foundation for later studies, and students should be allowed time to learn these. The engineering subjects are to give technological knowledge, transfer experience and introduce the work of the sivilingeniør. Subjects that provide a broad engineering scope are to lead to wide technological competence, whereas in-depth engineering subjects are to cover specialized topics. Non-engineering subjects are to put technology in a social perspective. There are about 720 subjects today, apart from projects. The Committee feels that this number should be reduced to about 630. It will be a challenge for NTH to take care of the links between subjects.

The Curriculum Development Committee recommends that:

- The work load is to be 48 hours a week (48 load units).
- The size of subjects is to be 12 load units, which means four subjects each semester.
- The number of subjects is to be reduced by about 13 per cent.
- More weight is to be placed on the basic subjects.
- The broad engineering subjects are to replace some of the in-depth subjects.
The non-technological subjects are to fill one complete semester, inclusive related topics for engineers in the examen philosophicum.

The Curriculum Development Committee proposes that the degree programme at NTH is to continue to be characterized by a controlled structure, with faculties and specialist areas. The programme is to be divided into three parts as presented in the figure. During the first part (1st-4th semesters) stress is to be on the basic subjects. In the second part (5th-7th semesters) the focus is to be on broad engineering courses and project-based teaching is introduced. In the third part, students are to do an interdisciplinary project that involves various specialist areas and faculties (8th semester). Specialization in engineering topics starts with an in-depth project in the 9th semester and students are to write their diploma thesis in the 10th semester.

The week before or after matriculation, an introductory course is offered which gives information about the degree programme at NTH, study techniques and other practical issues. A compulsory activity week for all students will be introduced in the middle of each spring semester, with seminars, courses, field trips and so on.

NTH is to award the degree of sivilingeniør and the programme is to be organized as a single degree.

The Curriculum Development Committee recommends that:

- NTH keeps the student class system based on specialization.
- In the eighth semester, project work is to involve students from other specialist areas and faculties.
- Exams are to be held the last three weeks before the Christmas and summer vacations.
- Work on the diploma thesis is to be increased to 20 weeks.

Teaching methods
Teaching methodology is a vital element in achieving the qualitative objectives of the sivilingeniør degree. The degree programme is to have high pedagogical quality and be based on a variety of teaching methods and provide the opportunity for in-depth study and reflection. The number of lectures is reduced to make more time for individual studies and projects. Problem-based teaching should be introduced in all the subjects in one of the small faculties and in at least one subject in each of the other faculties. The Committee feels that the revised curriculum will activate students in a better way than at present.

Exercises are to give practice in the formulation and solution of different problems, help the learning of the curriculum, and illustrate links between subjects. The number of exercises should be reduced. Some should be larger than now, and they should be better integrated. Group exercises are to be central during the first part of the programme with seminars being more usual in exercises in the second and third parts of the degree.
Project work is to teach students how to solve the types of tasks a sivilingeniør meets in daily life. Students are to get training in problem formulation, group work, control of complicated calculations, writing reports, and oral presentation. Smaller projects should be introduced in the first year, and they must get more complex later on. It is essential to stimulate creativity and innovation. The responsible teacher is to give students feedback on their work.

The Curriculum Development Committee recommends that:

- Lectures are still to be a main form of teaching but there is to be a 20% reduction per week on average.
- More individual work and project work is to be introduced into the degree programme.
- Project work is to be carried out as guided group work, with training in cooperation and communication.

Evaluation
Evaluation of students’ knowledge must be designed so that it promotes the required behaviour during the degree and measures the competence that is to be developed. It is said that examinations can only evaluate the factual knowledge acquired by students.

The Curriculum Development Committee recommends that:

- Written examinations are still to act as the main foundation for the evaluation of knowledge.
- Oral examinations and other forms of evaluation are to be used to a larger extent.
- Evaluation of the subjects is to be kept as at present.
- A quality system for the degree programme at NTH is to be developed.

Work experience
Work experience is an important part of the degree. The disciplinary benefit is getting hands-on experience of the typical tasks a sivilingeniør may be responsible for later on. It is also essential to get experience of manual and technical skills and do practical engineering tasks. The social benefits are that students are given insight into working life from the “floor”, knowledge of safety work, trades union and other relations. A committee should be established to report on the status of practical work experience at NTH.

The Curriculum Development Committee recommends that:
• Students are to have 12 weeks of practical work.
• NTH must work to expand this period of practical work.
• A six week practical project is to be integrated in the degree.

Internationalization
NTH has about 20 formal cooperation agreements with foreign universities. Today, over 10 percent of graduates from NTH have studied part of their degrees abroad. Though fewer foreign students come to NTH on exchanges, this number is increasing. Every seventh year, teachers at NTH have the opportunity to take a sabbatical year abroad, very few used this opportunity in 1993. These exchanges contribute to technical development, new impulses in education and research, and cultural understanding.

The degree programme at NTH is to place weight on clarity in written and spoken ability, both in Norwegian and English. The degree is to be continued to be taught in Norwegian in most subjects. Language teaching can be offered as elective, non-technical subjects.

The Curriculum Development Committee recommends that:
• About 20 percent of NTH students should study abroad for at least one semester.
• A Norwegian sivilingeniør should master both written and oral English.

The sivilingeniør of the future must have basic knowledge, training in solving complex and interdisciplinary problems, together with training in leadership and cooperation. These types of qualifications are learned through time-consuming forms of learning. In the future, the degree programme is to focus especially on wealth creation, resources and the environment, the interaction between technology and society and a greater degree of internationalization.

Resource requirements
Chapter four analyses the resource requirements. Compared to six foreign technological universities, NTH has the highest percentage of students completing their degrees (91%), but the lowest resources per graduate. Government funding per student at NTH has been reduced by 21% during the past decade. This has forced NTH to put a lot of effort into increasing the grant per student. At present, the faculties use about 80% of their budgets to pay salaries and 14% to cover operational expenses. This only leaves 6% for equipment. The Committee is concerned about the level of grants to NTH.

NTH now faces a situation with a deficiency of more than 70 teaching positions. The committee recommendation to extend the degree into a 5 year programme will necessitate more teaching staff and assistant teaching positions. Increased expenses for personnel and new premises, minus the reduction in examination costs is NOK 37 million a year, or 7% of today’s budget for the sivilingeniør degree programme. The need for new premises...
amounts to about 7100 m², which represents NOK 85 million in investments. The personnel costs in this transition period are calculated to be NOK 14 million a year over 5 years. The practical work experience project together with increased international exchange of students and teachers will amount to a total of NOK 26 million a year and should be implemented gradually. It is important that NTH looks at means of reducing these calculated costs.

The Committee feels that these recommendations will increase the quality of the degree programme so that the increased need for resources will be more than compensated for.

**Future schedule and further requirements**

The plan for implementing these recommendations is outlined in Chapter 5. The first admissions to the revised degree programme could be in 1996, with the first graduates from this programme in 2001. Preliminary planning can be initiated before the Ministry of Research, Education and Church Affairs has appraised these recommendations. The Committee recommends that immediate efforts are made both to standardize the size of subjects and launch the work experience project.

Chapter 6 concludes the report and touches on many aspects that have not been evaluated.

No priority has been made between the sivilingeniør, sivilarkitekt, Dr. Ing. degree programmes and activities in continuing education at NTH.

The Curriculum Development Committee has acknowledged the rich qualities of the sivilingeniør degree programme at NTH, nevertheless there is still potential for further improvement. The will of NTH and its staff concerning improvement is impressive. This is reflected by the title of this report:

**Engineering Education in the 21st Century**

**Notes**

1. The Committee used the following technological universities for comparison: Chalmers tekniska högskola and Kungliga Tekniska Högskolan in Sweden, Danmarks Tekniske Højskole, Technische Universität Delft in The Netherlands, Eidgenössische Technische Hochschule in Switzerland, Stanford University, USA and University of Japan.

2. This comparison is based on the same universities as in note 1.

3. The Committee based this comparison on a Swedish investigation that compared: Universität Karlsruhe (UK) and Technische Hochschule Darmstadt (THD) in Germany, Chalmers tekniska högskola (CTH) in Sweden, Imperial College of Science, Technology and Medicine (IMP) in England, Eidgenössische Technische Hochschule (ETH) in Switzerland, and Massachusetts Institute of Technology in the USA.
ENGINEERING EDUCATION
WITH A NEW PERSPECTIVE
(DRAFT)

English summary of the Report from the Evaluation Committee (VK2) on
Content, scope and structure
of
non-technological courses in the MSc Degree in Engineering
(sivilingeniørstudiet)

July 2003

Gunn Kari Hygen
Eirik Paulsen

Morten Loktu
Veslemøy Utengen

Jan M. Øverli

Gaute Myhreboest
Einar Aas

Age Søsveen
INTRODUCTION

This report contains the Evaluation Committee’s (VK2) recommendations for the future MSc Degree in Engineering at NTNU with regard to its non-technological courses*, their scope, content and structure.

The report has been made as brief as possible and much of the background material is subsequently to be found in the appendix of the report (Norwegian version of the report only).

The backbone of the MSc Degree in Engineering remains the technological courses, though it is necessary to supplement these with subjects from the humanities and social sciences.

Steel mainly consists of iron.

By adding other elements, the quality of the material may be significantly improved.

This is also true of graduate engineers.

The committee concludes that the non-technological courses will become even more important in the education of future graduate engineers.

* The term non-technological courses was introduced by the Evaluation Committee of 1993. The current committee has also decided to apply this term, even if some may have a negative attitude towards the word ‘non-technological’. In other contexts, the courses in question are also referred to as social science courses.
CONTENT

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1. SUMMARY

At the beginning of the new millennium we experience extensive and rapid changes in our society and economy. Countries and individuals are affected by various forces; technological, political, economic and cultural. The world changes as goods, capital and people flow more freely across national borders. Attitudes and values are spread across the world, cultures merge and social structures change. These changes are to a large extent based on the development of modern information and communication technology (ICT).

Norway faces great challenges and transformations in the private and public sectors. We experience fluctuations with significant structural changes. Our industry faces considerable demands for rationalization and innovation. Greater wealth creation is necessary in order to ensure our welfare. One challenge is to develop new types of knowledge-intensive and service-oriented companies in new areas.

It is expected the exploitation of the knowledge economy will be the main source of economic growth in the future. Intellectual capital will be our most important competitive edge.

The tasks of the knowledge society will be more interdisciplinary and complex and new demands will be placed on organizational structures and production processes. Project work and teamwork will address challenges and become more commonplace and the participants need to be able to communicate and understand the experience of other team members as well as their professional and social backgrounds.

At the same time, the attitudes of employees towards work and professional life will become increasingly more varied and complex. This affects things like working hours, participation, initiative and freedom, co-ownership, remuneration, delegation, flexibility and individual solutions.

The MSc Degree in Engineering at the Norwegian University of Science and Technology (NTNU) must be able to prepare students for modern working life.

At the heart of the information-intensive working life is the quality of the education. The ability to learn is becoming more important in covers all levels of society. Life-long learning is becoming a necessity. We need scientific environments and people capable of discovering, understanding, developing and applying new knowledge.

Both society and the industry demand graduate engineers with action-oriented skills who must be able to cope with a rapidly changing working life that demands continuous adaptation.

In this context, the MSc Degree in Engineering needs to be supplemented by a ballast of courses in the humanities and social sciences in order to enable students to understand their subject in a broader context, complete their educational skills, increase their understanding of other subjects, learn more about the consequences of technology and be able to assume executive positions. This idea provided the basis for the Evaluation Committee of 1993 (VK1), which paved the way for an increasing amount of non-technological courses in the MSc Degree in Engineering.

The Evaluation Committee (VK2) concludes that the objective defined by the Evaluation Committee of 1993 for the MSc Degree in Engineering is still valid:

"The overall objective is a degree programme that gives students knowledge, skills and attitudes, and relevant professional competence"
Furthermore this is to enable students to develop the relevant action-oriented skills that are necessary in order to meet the requirements and meet the challenges of the private and public sectors.

The Evaluation Committee has sought to establish how this objective could be reached in the best possible manner.

Based on the work and assessments already completed, the Evaluation Committee (VK2) makes the following recommendations in order to enhance the quality of the part of the education that is described as non-technological courses:

- **The MSc Degree in Engineering should still consist of 4 non-technological courses (IKKETEK 1, 2, 3 and 4).**

- **IKKETEK 1 (Ex.phil.) is taught in the 4th Semester with revised content in philosophy, ethics, the history of science, logic, and communication theory.**

- **IKKETEK 2 in the 5th Semester is a compulsory common introductory course for all graduate engineers students with the following content (weighting given in %):**
  - Organization and management/Work and organizational psychology (30 %)
  - Economics (30 %)
  - Legal issues (30 %)
  - Business development and innovation (10 %)

- The lectures in IKKETEK 1 and 2 are coordinated so that the courses are more clearly an integrated part of the MSc Degree in Engineering and a basis for the further selection of non-technological courses.

- **IKKETEK 3 is taught in the 7th Semester and chosen from a selection of non-technological courses that are adapted to the profile of the separate programmes of study established by Programme Committee.**

- In the 9th Semester, the students can freely select a non-technological course (IKKETEK 4) from the courses offered by NTNU.

- For students preferring more in-depth studies in the non-technological courses, the principle of an optional course module in the 8th Semester is maintained.

- Attitude- and skills-developing issues are primarily integrated in the ordinary courses or as a part of the learning process and pedagogical structure. The Interdisciplinary Teamwork project represents a key element.

- The experience from the new courses IKKETEK 1 (Ex.phil.) and IKKETEK 2 (common introductory course) is to be evaluated after 3 years.

- It is recommended that Ex.fac. in the 1st Semester includes report writing and oral presentations and continues to be based on the group-based introductory sessions in mathematics at the start of the semester.
VK2 also recommends that:

- NTNU is to a far greater extent attempt to create opportunities for graduate engineers to take further and continuing education in non-technological courses.

2. THE COMPOSITION, MANDATE AND FORM OF WORK FOR THE EVALUATION COMMITTEE

The Rector of NTNU appointed a new Evaluation Committee (from now on also referred to as VK2) in order to undertake a comprehensive evaluation of the structure of the future MSc degree in graduate engineers with regard to its non-technological courses; their scope, content and structure.

The Evaluation Committee consisted of the following members:

Managing Director Jan M. Øverli, PFI (head)
Managing Director Gunn Kari Hygen, Næringsforeningen i Trondheim
President Morten Loktu, SINTEF
Director Gaute Myklebust, Atmel Norway
Student Eirik Paulsen, NTNU
Student Veslemøy Utengen, NTNU
Professor Einar J. Aas, NTNU
Senior Advisor Åge Søsveen, NTNU (secretary)

The appointment and mandate for VK2 are given in Appendix 1.

VK2 completed its work in about 3 months. The committee held four meetings and during its work sought to:

- Assess the MSc degree in engineering in relation to NTNU’s strategies and the requirements of the Quality Reform.
- Revise the objective of the MSc degree in engineering at NTNU
- Assess the status and already defined objectives of the non-technological courses at NTNU
- Assess and emphasize the non-technological subjects that future graduate engineers ought to be familiar with

VK2’s evaluation and recommendations have been based on the following activities. The committee has:

- Carried out a comprehensive survey among graduate engineers with degrees from NTH/NTNU
- Organized a seminar with broad participation from internal and external key staff.
- Organized evaluation meetings with relevant academic groups at NTNU
- Obtained relevant information concerning Ex.phil. from other Norwegian universities
- Organized an open hearing with NTNU’s management and its faculties

Based on this, VK2 submits its report on the non-technological courses at NTNU.
3. THE POINT OF DEPARTURE FOR THE COMMITTEE WORK

3.1 A time of transformation

3.1.1 The world

At the beginning of the new millennium we experience profound changes in our society and industry. As never before, countries and individuals are affected by various forces; technological, political, economic and cultural. At the dawn of the new millennium our society and industry are facing profound changes.

This transformation is marked by:

- How we are unable to predict the future, beyond recognizing that it will be different
- Changes that are far more profound than we think
- Changes that are occurring faster than we think
- We perhaps fear these changes, but we cannot avoid them

The world is changing as goods, capital and people move more freely across national borders. International trade and investment are on the rise, more companies are organized across national borders, and what were previously domestic markets are exposed to international competition. Attitudes and values are spread, cultures merge and social structures change.

The post-industrial society is based on knowledge, education and information and marked by global transformation.¹ The changes to a large extent reflect the development in information and communication technology (ICT), which paves the way for new types of interaction via electronic media. An increasing number of people use computers, the Internet, cellular phones and on-line services both at home and at work. The technology increases the speed of information processing, removes geographical barriers and transcends time and national boundaries. The whole world can access the same news and entertainment products.

The world faces great challenges. These include climatic change, resource scarcity, sustainable energy production and consumption, pollution of the air and water, biological diversity, migration, regional conflicts and the divide between rich and poor countries. The solution to these challenges demands the capability to have international understanding, cooperation and solidarity.

3.1.2 Norway

Norway is a small country. We are blessed with abundant natural resources, enjoy a life of plenty, high levels of employment, an equal distribution of income, social security and advanced welfare services. At the same time, we need to cope with extensive challenges and changes in the private and public sectors if we are to preserve our welfare system.²

Norwegian industry is currently passing through what in some cases amount to dramatic changes, and we experience fluctuations with significant structural transformation. The income from the oil and gas industry plays a dominant role. However the rest of the industry is struggling to keep pace with the economies of our trading partners. Our high cost level makes it difficult to remain competitive in the
world market. Industrial production is closing down and re-opened in low-cost countries. The awareness of resource scarcity and environmental considerations is growing. New demands for flexibility and innovation are placed on our industry. The road from research and development to saleable products becomes increasingly shorter.

Increasing growth is a main challenge in the attempt to secure our welfare. Our industrial growth is largely based on raw materials. The rich natural resources will continue to dominate Norwegian industry. At the same time, it is important that a larger share of the processing takes place within Norway. Last but not least, we need to develop new sorts of knowledge-intensive and service-based companies within new fields of activity.

It is expected that the exploitation of the knowledge economy will become the most important source of growth in the future. Intellectual capital becomes the key competitive factor.³

The public sector in Norway also faces great challenges. We expect more from the public services and the tasks become more numerous. The ambition is to make the public services as efficient as possible.

This also involves opportunities. However, these will require a sound knowledge base with higher and more evenly distributed skills at all levels in society.

Although there are numerous challenges we have the capability to cope with them. Norway has greater freedom than most other countries. Education and research must be actively applied in order to strengthen the economy and sustain our welfare system.

### 3.1.3 Challenges for the knowledge society

In a knowledge-intensive working life, the quality of the educational system is crucial. Increasing globalization will demand common norms and skills requirements. Future graduates will need better language skills and broader cultural understanding. This is particularly important in a small country like Norway.

With a society in transformation, the ability to learn will be of major importance. Education and training will no longer be a once-in-a-lifetime experience. Life-long learning becomes a necessity.⁴

Work tasks become more interdisciplinary and complex and new demands are placed on organizational structures and production processes.⁵ Project work and teamwork will become more commonplace and the participants need to be able to communicate and understand the experience as well as professional and social background of each other.⁶ Internationalization and a more detailed regulation of society through laws, rules and regulations will require a broader understanding of legal matters. It is necessary to find means and regulations that emphasize a feeling of belonging, well-being and motivation.

The attitudes of employees towards work and professional life will also become increasingly more complex. This affects things like working hours, participation, initiative and freedom at work, co-ownership, payment according to effort, delegation of responsibilities, organizational flexibility and individual solutions.⁷

It is often stated that knowledge is the key to the future. Technological development has generated new possibilities within industrial development, the spread of culture and welfare measures. In order to participate in this process we must ensure that we cultivate academic environments and people that are capable of obtaining, understanding and applying new knowledge.
In this context, the Norwegian University of Science and Technology (NTNU) has a particularly important role to play as a leading institution in engineering education and research.  

We need graduate engineers with action-based skills that enable them to tackle the demands and challenges of society and industry. They must be able to meet the rapid changes in working life that require continuous adaptation.

3.2 Premises for the report on non-technological courses in the MSc Degree in Engineering.

The report is based on the following key strategic documents:

- NTNU’s strategic plan
- NTNU’s education strategy
- The Quality Reform
- The report from the Evaluation Committee: ”Engineering Education in the 21st Century” of 1993 (from this point on referred to as VK1)

3.2.1 NTNU’s strategic plan

The strategic plan contains five key objectives:

- NTNU is to be a leading international university within its core area of activity – technical and scientific research and education.

- NTNU is to offer a broad range of subjects and at an international level in all parts of its activity.

- NTNU is to be a model university in the interaction and cooperation between the various subject areas.

- NTNU is to be a critical and constructive contributor to society, with a comprehensive and reflected approach to society’s tasks and challenges.

- NTNU is to actively apply the skills of women in academic developments.

3.2.2 NTNU’s education strategy

The strategic plan is described more closely in NTNU’s educational strategy which is based on some key principles. These can be divided into three main objectives:

- Through their studies, NTNU graduates should have acquired relevant skills that will match the demands of society and their future profession.

- The knowledge, skills and attitudes to be acquired by the student must form the basis for both the methods of learning and evaluation.
- NTNU’s courses should not be restricted to just the acquisition of knowledge. The studies and the learning environment in a broad sense should enable the students to develop skills and attitudes that provide them with a sound knowledge base. These skills and attitudes should reinforce students' ethical consciousness, develop their respect and curiosity for the experience and academic viewpoints of other students and strengthen their ability to interact with others.

3.2.3 The Quality Reform

The Quality Reform is largely based on the same key objectives and principles as expressed in NTNU’s strategies, though it elaborates further on these.

The main objective of the Quality Reform is to ensure good quality education through a range of academic, pedagogical and educational measures. The emphasis has been changed from teaching to learning.

The question is: What does the student learn? The basic philosophy of learning is based on the following principles:

- Learning is a process in which the student is responsible for his/her own learning. The professors, teaching assistants and infrastructure represent a support apparatus and the catalyst for the learning process. In order to maintain an effective process, the student should be followed up closely throughout his/her studies.

- Teaching and evaluation methods should be based on criteria aimed at ensuring the best possible learning, where formative (corrective) evaluation is given more emphasis than traditional summative (non-corrective evaluation or exams).

- The education should take place in a broad, social perspective.

- The education should enable the student to acquire action-oriented skills, which is the sum of knowledge, skills and attitudes. Such skills can be obtained through pure acquisition of knowledge, selected pedagogical methods and the use of tools (ICT, languages, group work, projects, methods for problem solving).

- The learning is based on and supported by skills acquired from courses and subjects that the student has already completed or follow at the same time as his/her main subjects. The student is thus able to develop his/her skills.

3.3 Evaluation of the current MSc Degree in Engineering in relation to the objectives

The current MSc Degree in Engineering is based on the report by the Evaluation Committee of 1993\textsuperscript{11}, which describes a number of objectives and principles for the education.

The main philosophy is the so-called “fade in–fade out” principle. This means that the study gets underway with some basic introductory courses in technological, scientific and non-technological subjects. When the required level has been reached, the introductory courses are phased out and replaced by more specialized courses. The student should acquire knowledge as close as possible to the level where it is to be applied to new subjects.
VK1 also viewed the integration of different subject areas into the same course as a key principle and subsequently introduced an interdisciplinary project in the 8th Semester (Interdisciplinary Teamwork) as a manifestation of this principle. Interdisciplinary activity has always been important to the MSc Degree in Engineering. This was continued by VK1 through the introduction of a course in engineering from a different degree programme in the 8th Semester; the so-called interdisciplinary semester.

The weight of the non-technological courses was increased from 18 to 30 credits. Still, there was no comprehensive review of the non-technological courses with regard to their objectives, content and nominal length of study.

The decisions and guidelines that have been agreed in connection with the implementation of the Quality Reform at NTNU have made it difficult to build up a curriculum based on the principles described in the reform.

VK2 considers that the various rulings from NTNU about the non-technological courses in the curriculum have failed to put these courses into a comprehensive social perspective.

4. THE OBJECTIVES OF THE MSC DEGREE IN ENGINEERING AND ITS NON-TECHNOLOGICAL COURSES

4.1 Primary objective of the MSc Degree in Engineering

The content, scope and integration of the non-technological courses in the MSc Degree in Engineering must be seen in relation to the objective behind the education and what one seeks to achieve with the degree.

In the final report of VK1\textsuperscript{11} the committee defined the overreaching objective of the MSc Degree in Engineering at NTH. This definition was approved by the Board of NTH in 1994.

"The overall objective is a degree programme that gives students knowledge, skills and attitudes, and relevant professional competence"

VK2 considers that this definition is still valid.

4.2 Qualitative objectives of the education

VK1 agreed on several\textbf{ qualitative objectives} for the MSc Degree in Engineering.

In a survey carried out by VK2 (see Section 5.1), the respondents were asked to name what they considered to be the most important sub-objectives for the MSc Degree in Engineering in general and the non-technological courses in particular.

Given the response and the social transformation witnessed over the last few decades, the committee has adjusted the formulation of some of the sub-objectives of the MSc Degree in Engineering. The objectives below are not given in prioritized order:
Learning outcomes for the MSc Degree in Engineering

The education is to provide students with:

Knowledge
- Sound scientific basic knowledge that will provide a platform for the understanding and application of engineering methods, adaptive versatility to innovation, development of scientific and technological knowledge and changing economic and environmental conditions and priorities
- Broad scientific knowledge in engineering
- Research-based specialization in specific areas

Skills
- Training in defining, analysing and modelling complex engineering challenges
- Training in creating a synthesis of comprehensive solutions that may involve several technological and non-tech subjects
- Training in creative work and innovative activities
- Training in assessing calculations and results
- Training in teamwork and communication
- Training in leadership and the motivation of colleagues

Attitudes
- Stimulation towards being innovative and creating economic and environmental viable activities
- Entrepreneurial ability that can translate research results into commercial opportunities
- Ethical values and basic attitudes that enhance the understanding of engineering knowledge and activities as an influential and integral part of a comprehensive social and environmental fabric

4.3 Non-technological courses in the MSc Degree in Engineering: Definition and objectives

VK1 emphatically concluded that the share of non-technological subjects ought to be increased. VK1’s objective and definition regarding the non-technological subjects are given in the main report:

"The non-technological subjects could both affect professional aspirations and cultivation of attitudes. Among other things, they aim to view technology from a social perspective, which in turn will enable graduate engineers to predict and assume responsibility for the consequences of their decisions. The subjects are meant to increase the understanding of other disciplines and contribute to greater variation and scope in a technologically oriented education. They include courses that create the basis for future executive roles."

The Evaluation Committee recommends that subjects related to Examen philosophicum (Ex.phil.) for engineers are included in the compulsory non-technological courses.”

In the report from VK1’s sub-project 3: "Disciplinary profile", the non-technological courses are mentioned more precisely:
“They include subjects and courses such as the history of technology, management, psychology, languages, economics and law. The objective of the social sciences is to bring technology into a social context. Technology is a response to the requirements of society; not merely an applied natural science. The social sciences should increase the understanding of other disciplines and contribute to variation in a technologically dominated education.”

In the survey (Appendix 2), VK2 asked the students to indicate their preferences in a selection of sub-objectives for the non-technological courses. This was also discussed in a management seminar organized by the Committee (see Section 5.2).

The views expressed at the seminar corresponded closely with those of the Committee.

Based on this, VK2 defines the main objective of the non-technological courses as follows:

The aim of the non-technological courses is to bring the main subject into a broader perspective, complement the disciplinary skills, increase the understanding of other disciplines, learn more about the consequences of technology and create a basis for the future tasks of an executive.
5. SOCIETY’S REQUIREMENTS

5.1 Survey

One key objective in including non-technological courses in the MSc Degree in Engineering is to enable the graduates to view their profession in a wider social perspective.

VK2 wanted to get the opinion about the MSc Degree in Engineering from people in Norwegian society and industry in general, especially with regard to the content of the non-technological subjects.

The Committee decided to use a web-based system in order to undertake a survey. With the given resources and time framework, it was decided to carry out a survey among a statistical sample of engineering graduates from NTH/NTNU. As a large portion of these are organized in the Norwegian Association of Chartered Engineers (NIF), the association produced a sample of about 3000 people among its total membership of approximately 40 000. The distribution of the respondents is shown in Appendix 2. 1397 people responded to the questions.

The 20 questions to be answered were partially based on a similar survey from the VK1 report of 1993, though the Committee also added some new ones.

The survey gave the Committee some clear answers:

a) The MSc Degree in Engineering is primarily a technological education. It is important to ensure that there is a sound understanding of the key subjects and courses in engineering as a basis for life-long learning. Several non-technological subjects can be learned through practical experience.

b) The amount of the non-technological courses in today’s curriculum is sufficiently high and ought not to be increased, as the quality of the basic technological education already is imperilled. Quality should be given more emphasis than quantity in the subjects and courses.

c) It is important that the MSc engineering student is given a basic understanding of the social consequences of technology. The student must learn to view technology in a social perspective and develop humility and respect towards other subject areas.

d) The non-technological courses that have been central when working as a graduate engineer (in order of priority):

- Teamwork
- Organization and management
- Dissemination of knowledge
- Economics
- Work and organizational psychology

Other subjects: Languages, HES, Marketing, Legal issues and Industrial Development.

e) Subjects aimed at developing skills and attitudes should preferably be integrated into the ordinary courses.

f) The MSc engineering student is primarily motivated by technological subjects at the start of the study, and subsequently lacks the maturity and motivation needed for education in non-technological courses. Because of this, these courses ought to be offered at a later stage of the
education, or possibly be taken as continuing or further education courses. The use of non-
technological courses is often not revealed until one has started working in a professional 
career.

g) The graduate engineer must develop understanding, respect and motivation with regard to the 
influence he/she exercises in society through his/her professional activity.

h) The basic education should provide the students with understanding of some fundamental 
principles within ethics, general inter-personal skills (i.e. teamwork), HES, sustainable 
development and industrial ecology. Technological and non-technological courses should 
reinforce each other. In-depth studies in subjects such as law, economics and management 
could be taken as continuing and further education, as the demand becomes evident. Parts of 
this education may well be carried out in cooperation with the sectoral organizations.

i) The graduate engineer should not be a specialist. What is demanded is a comprehensive view in 
order to reach good solutions that are economically sustainable, ethically defensible and 
practical. These are discovered through coordination with other subject areas, but also require a 
basic understanding on the part of the graduate engineer with regard to the strengths and 
weaknesses of his/her own education.

The distribution of the answers as well as more detailed premises and analyses of the survey are given 
in Appendix 2.

5.2 Management seminar

VK2 organized a seminar with about forty participants, in which nearly half have senior positions in 
industry and civic life, whereas others were representatives of NTNU.

The participants at the seminar covered a broader range of subject areas than the NIF members taking 
part in the survey. Among the participants were representatives of the social sciences, humanities and 
technological subject areas. Also present were representatives from industry, administration, education 
and research (Appendix 3).

The aim of the seminar was to evaluate and discuss the response from the survey as well as to 
exchange opinions and experience concerning key non-technological courses in the MSc Degree in 
Engineering.

The seminar gave some clear signals about what non-technological subjects that ought to be given 
priority in the MSc Degree in Engineering:

- Management with an emphasis on practical understanding, including project management, 
motivation, work and organizational psychology and teamwork
- Industrial development, innovation and entrepreneurship, including legal subject
- Communication, dissemination and marketing
- Economics

This response was of fundamental importance to the prioritizing of subjects in the Committee's report.

A more comprehensive summary of the key arguments from the seminar is given in Appendix 3.
5.3 Faculty hearing

VK2 prepared a preliminary report as a basis for an open hearing with the Board of NTNU, the faculties and programmes of study in the MSc Degree in Engineering at NTNU.

The Committee presented two alternative proposals for a new course (IKKETEK 2).

**Alternative 1:**
The proposal involves a new common course (IKKETEK 2) for all students, where 4 subjects are included in a comprehensive course (weighting given in %):

- Organization and Management/Work and organizational psychology (30 %)
- Business administration (30 %)
- Legal issues (30 %)
- Business development and innovation (10 %)

It is important to offer a proper introduction to the separate subjects. All students are offered the same courses and will subsequently have the same basis for further in-depth studies in any optional subjects.

**Alternative 2:**
The proposal means that 50 % of the course (organization and management/work and organizational psychology) is common for all students.

In the other half of the course, the student should select 1 out of 4 subjects of specialization:

- Economics
- Legal issues
- Business development and innovation
- Communication, dissemination and marketing

This has an advantage insofar as the student is able to specialize in the subject of his/her choice.

The disadvantage is that the student will implicitly decide not to select other important subjects (i.e. economics), which is beneficial for all students. The students will also have different levels of preliminary knowledge before starting their specialization in non-technological courses later in the study.

The participants at the hearing emphatically favoured Alternative 1 with one comprehensive common course.

VK2’s proposal to include Ex.phil. in the 4th Semester was also discussed, but without any definite conclusion being reached.

The participants also asked about the possibility of giving more flexibility to the separate programmes of study in relation to IKKETEK 3, which the committee proposed to be included in the 7th Semester. While the committee views this idea with sympathy, this is something that largely depends on the established timetables. The overall requirement must still be that the academic progression in the programme of study is taken into account.
VK2 recommends that the proposed position of the course is adopted.

Apart from this, the hearing produced a number of valuable arguments. Among them, stronger commitment to NTNU’s strategic objectives was asked for. Otherwise, the participants at the hearing generally supported to the Committee’s proposals.

The Committee has included the arguments presented at the hearing in the current report.

6. THE EX.PHIL. SUBJECT IN NORWAY FOLLOWING THE QUALITY REFORM

The purpose of Ex.phil. is to place the student’s main subject area in a broader historical, disciplinary and social context, as well as developing his/her skills in abstraction, logic and argumentation.

The commitment of the Ex.phil.students varies a great deal, from the highest to the lowest level. The student’s subject area is not a decisive factor. Some of the best performers have been MSc Engineering students. The divide seems to go between those who understanding the purpose of the subject and those who do not. A formative evaluation that was carried out seems to indicate that there is hardly any correlation between the effort made and marks achieved in the subject.

VK2 is of the opinion that Ex.phil. has a somewhat different function for students following programmes of professional studies compared to those pursuing a more general education.

MSc Engineering students have already selected their curriculum and are primarily interested in developing a clear understanding of their subject at an early stage in their study. Those following programmes of professional studies would subsequently benefit from studying Ex.phil. at a later stage in their study, as this would among other things help to bring some structure to his/her scientific knowledge before selecting further specialization. Those pursuing a more general education would benefit from studying Ex.phil. at an early stage as this would help them make decisions with regard to their further studies.

The Committee is subsequently of the opinion that there are academic and pedagogical reasons for discussing an alternative position of Ex.phil. for those following programmes of professional studies. This would also involve a logistical advantage for the Ex.phil. lecturers in Module 1, who may be responsible for as many as 3400 students in the autumn semester and only a limited number in the spring semester.

Representatives of VK2 have had a broad discussion with the Department of Philosophy and the Ex.phil. lecturers at NTNU concerning the situation following the Quality Reform.

The Committee has also obtained information from three of the other universities about their decisions regarding Ex.phil. in connection with the implementation of the new Act relating to universities and university colleges.10

The main content of Ex.phil. seems to be largely the same at the three universities (Oslo, Bergen and Tromsø), though the emphasis on some of the subjects varies slightly according to university, department and curriculum. The scope of the course is 10 credits.

The teaching methods include lectures, seminars, individual and group exercises as well as an oral/written examination.
The position of Ex.phil. in the curriculum:

- The University of Oslo: The position varies according to programme of study. In some programmes of study, the course is not taken until the 5th and 6th Semesters.

- The University of Bergen: Ex.phil. is included in the 1st Semester of all programmes of study.

- The University of Tromsø: Ex.phil. is included in the 1st Semester of all programmes of study, with the exception of the MSc Degree in Engineering, where the course is likely to be included in the 4th and 6th Semesters.

The Committee has taken this information into account.

See Appendix 4 for more information, assessments and discussions.

7. THE COMMITTEE’S ASSESSMENTS AND RECOMMENDATIONS

7.1 Structure of non-technological courses in the programme of study

The Committee recommends the following structure for the non-technological courses in the MSc Degree in Engineering:

<table>
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<th>Part</th>
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- THESIS (20 weeks)
- COURSE OF SPECIALIZATION (projects + supplementary courses)
- Optional course
- ENG
- Optional course
- EX.FAC.

**MAT** = course in mathematics  
**MATNAT** = other course in mathematics and natural science  
**TEKBAS** = technological introductory course  
**ENG** = course in engineering  
**IKKETEK** = non-technological course  
Shading indicates compulsory courses
With some simplification the structure of courses can be considered as two parallel paths that are somewhat staggered in relation to each other:

- The technological courses begin with a technological introductory course (Ex.fac.) in the 1st Semester and end with a course of specialization in the 9th Semester.
- The non-technological courses begin with a compulsory non-technological introductory course (Ex.phil.) in the 4th Semester and ends with an optional course in the 9th Semester.

### 7.2 Selection of non-technological courses

a) VK2 is of the opinion that the MSc Degree in Engineering still ought to include 4 non-technological courses, with the possibility of selecting an additional course module (8th Semester).

b) The various non-technological courses have a somewhat different character. All courses are fundamentally knowledge-based, though some of them can also be considered skills-developing and/or attitude-oriented courses. The courses may be included in the education in different ways:

- **Knowledge-based courses** (management, Legal issues, marketing, economics) should be offered at different levels (know- > learn - > master). The choice of courses should also to some extent be seen in relation to the main programme of study.

- **Skills-developing courses** (project management, use of ICT-related tools and languages) should be included in the pedagogical structure of the education (i.e. the project Interdisciplinary Teamwork, student exchange, teaching assistant experience). However, some of the larger, more knowledge-based subjects (languages, subjects related to the handling of equipment) should be offered as optional subjects at a late stage in the study.

- **Attitude-oriented courses** (ethics, ecology, group dynamics, communication) should primarily be integrated in the ordinary courses or the pedagogical structure of the study.

It is important that the study is based on a coherent learning process, with a natural progression and continuity in the selection of courses, sequence, content and level.

c) The Committee presupposes that the first technological introductory course (Ex.fac.) also includes an introduction in study techniques, use of basic ICT tools, attitudes- and skills-developing subject (technical drawing, laboratory work, report writing, oral presentations).

VK2 is of the opinion that Ex.fac. should continue to be based on the group-based introductory sessions in mathematics which now is offered to all students at the beginning of the 1st Semester.

d) VK2 recommends that IKKETEK 1 (Ex.phil.) is included in the 4th Semester, which is the last semester before the selection of the programme option. This will mark the beginning of a logical string of non-technological courses in the study.
In the 4th Semester the student would have gained so much knowledge of his/her subject area that he/she will be better prepared and more motivated to study the non-technological perspectives in the programme of study.

e) In the 5th Semester, the course module IKKETEK 2 is offered as a compulsory common introductory course. This module must contain the main non-technological courses that all students ought to be familiar with.

The Committee finds it particularly important that the time-gap between IKKETEK 1 (Ex.phil.) and the next non-technological course (IKKETEK 2) does not become too large.

f) In the 7th Semester, the students can choose a non-technological course (IKKETEK 3) that is more specifically related to the selected programme of study. Here, each programme of study defines a limited menu of non-technological courses that is adapted to the overall profile of the programme of study (ref. Learning objectives). The different profiles underscore the importance of offering different courses.

Possible subjects could be management, linguistics, economics, business development, HES, medicine for non-medical students, contract law, project management and marketing.

g) In the 9th Semester based on individual interests and overall objectives for the study, the student selects one course freely (IKKETEK 4). This could be a specific subject among the ones offered in the 7th Semester, which include ethics, Legal issues, languages, cultural studies, communication and dissemination, or a freely selected course from an entirely different subject area.

h) For students preferring greater specialization in non-technological courses, the Committee recommends that an optional course module in the 8th Semester is maintained, possibly with guidelines ensuring relevance and coherence in relation to the main study profile.

7.3 The content of courses IKKETEK 1 and IKKETEK 2

VK2 held two meetings with the academic groups responsible for IKKETEK 1 (Ex.phil.) and IKKETEK 2 at NTNU.

Given the objective that all courses, including the non-technological ones, should be part of an overall structure and add some perspective to learning in the main subject area, the Committee has been concerned with how the the Ex.phil. course can be viewed in relation to IKKETEK 2.

The Department of Philosophy and the Ex.phil. lecturers have suggested which subjects ought to be taught at NTNU (from the autumn of 2003 onwards).

The main content of Ex.phil. is described as:
- Philosophy and the history of ideas
- The theory of science
- Ethics
- Training in scientific argumentation and logical reflection
On the basis of VK2’s assessments, the Committee wishes to give priority to the following subjects in IKKETEK 2:

- Organization and management/Work and organizational psychology
- Economics
- Legal issues
- Innovation and entrepreneurship
- Communication and dissemination

In the meetings with the Department of Industrial Economy and Technology Management at NTNU it was agreed to suggest a new course module IKKETEK 2 that covers the first four subjects.

The content of IKKETEK 2 should be (weighting given in %):

- Organization and Management/Work and organizational psychology (30 %)
- Economics (30 %)
- Legal issues (30 %)
- Business development and innovation (10 %)

Together with the Department of Philosophy, VK2 has discussed how a common Ex.phil. course at NTNU could more clearly be integrated into a comprehensive curriculum.

We concluded that the content of the curriculum had become quite extensive, given the scope of 7.5 credits. At the same time, there are obvious connections between the two courses (IKKETEK 1 and 2) with regard to communication and dissemination.

By viewing the courses in relation to one another, one would be able to establish a system of exercises in IKKETEK 2 that is based on the content of Ex.phil. (ethics, training in scientific argumentation and logical reflection as well as writing).

Both courses would fulfil the demand to offer basic skills in communication and dissemination

VK2 presupposes that the respective academic groups cooperate on both pedagogical structure and exercises in courses IKKETEK 1 (Ex.phil.) and IKKETEK 2 (compulsory introductory course).

The relevant departments have continued to work on the drafts and produced short descriptions of both content and pedagogical structure of the education in the two courses.

A description of the new courses IKKETEK 1 and IKKETEK 2 is shown in Appendices 5 and 6.

In order to coordinate the two courses, the two departments have already established a joint group with two representatives from each department and one representative from VK2.

During the discussions held with the two departments, some basic considerations emerged that ought to be incorporated into the subsequent work:

- Ex.phil. is basically a general introductory course, but with a technological and natural science profile that ought to be common for all students at NTNU. Traditionally, the course has been
taught in the first semester. To move it to a later stage of the education would alter the nature of
the course somewhat, though it is fully possible to introduce pedagogical adjustments.
However, it is important that the curriculum and content remain the same for all students at
NTNU.

- It is crucial that there are clear guidelines with regard to the responsibilities and the mutual
respect for the integrity of each other in the disciplinary cooperation. It is also important that
the academic groups maintain the disciplinary and pedagogical responsibility for their
respective modules.

- The consequences and requirements that a more integrated educational structure might involve
for the available resources need to be taken into account.

One needs to be prepared that it will take a while before the cooperation and disciplinary integration
have been sufficiently developed. The experience should be evaluated following a test period.

It is recommended that the experience with the new courses IKKETEK 1 and IKKETEK 2 is evaluated
after 3 years.

7.4 Continuing and further education in non-technological courses

VK2 concludes that life-long learning is a necessity. This means that employed graduate engineers
need to renew and further develop their skills during their professional careers. Several of the
respondents in the survey emphatically stressed that this was necessary and also that it would be
beneficial to take many of the non-technological courses after the MSc Degree in Engineering.

The Committee recommends that NTNU assumes the overall responsibility for offering continuing and
further education in non-technological courses, as the university is based on a strong technological and
interdisciplinary profile.

The Committee recommends that NTNU to a far greater extent aims at offering continuing and further
education for graduate engineers in the non-technological courses.

8. CONCLUSION

Through its work, the Evaluation Committee (VK2) received confirmation that the MSc Degree in
Engineering at NTNU contains several qualities.

However, given the rapid and profound social transformation we are presently experiencing, it is still
necessary to develop the quality of the education further. We need graduate engineers with the will and
capability to confront these challenges.

When revising the education, It is important that both the technological and non-technological courses
are viewed in the broad social context and that the students are offered a more comprehensive
perspective.
The Committee has subsequently named the report:

**ENGINEERING EDUCATION WITH A NEW PERSPECTIVE**

9. REFERENCES

2. NOU 2000: 21 En strategi for sysselsetting og verdiskaping
7. NOU 1999: 34 Nytt millennium – nytt arbeidsliv?
8. Strategi for NTNU mot 2010: Kreativ – Konstruktiv – Kritisk (NTNU’s strategic plan)
9. Undervisningsstrategi for NTNU fram mot 2010 (NTNU’s education strategy)
10. APPENDICES

1. Members and mandate of the committee.

2. Questionnaire on Non-technological subjects in the MSc Eng. Education (Enclosed in Norwegian)

3. Main issues from seminar with industry representatives and NTNU-leadership

4. Ex.phil.-subject in higher education in Norway after the Quality Reform 2003

5. Proposal on the content of the new subject NONTECH 1

6. Proposal on the content of the new subject NONTECH 2
Appendix 2: Questionnaire on Non-technological subjects in the MSc Eng. Education

A. Statistisk fordeling av utsendte spørreskjema til aktuelle respondenter

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</tr>
<tr>
<td>Bank, finans, forsikring og eiendomsdrift</td>
<td>0.6 %</td>
</tr>
<tr>
<td>Konsulentvirkomhet/rådgivende ingeniør</td>
<td>10.9 %</td>
</tr>
<tr>
<td>Offentlig forvaltning, kommune</td>
<td>3.3 %</td>
</tr>
<tr>
<td>Offentlig forvaltning, stat</td>
<td>8.2 %</td>
</tr>
<tr>
<td>Undervisning og forskning</td>
<td>9.4 %</td>
</tr>
<tr>
<td>Annet</td>
<td>4.1 %</td>
</tr>
</tbody>
</table>

**8. Hva synes du bør være de 5 viktigste målene for sivilingeniørutdanningen (kryss av for 5 alternativer)?**

<table>
<thead>
<tr>
<th>Andel</th>
<th>Mål</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.2 %</td>
<td>Etiske verdier og grunnholdninger som styrker forståelsen av ingeniørfagene rolle i et helhetlig samfunns- og miljøperspektiv</td>
</tr>
<tr>
<td>86.6 %</td>
<td>Gode vitenskapelige basiskunnskaper, som utgangspunkt for metodeforståelse, anvendelse, faglig fornyelse og omstilling</td>
</tr>
<tr>
<td>58.0 %</td>
<td>Brede ingeniørfaglige kunnskaper</td>
</tr>
<tr>
<td>10.4 %</td>
<td>Forskningsbaserd fordypning innen et begrenset felt</td>
</tr>
<tr>
<td>41.5 %</td>
<td>Stimulering til innovasjon og verdiskapning</td>
</tr>
<tr>
<td>19.5 %</td>
<td>Entreprenørskap, omsette forskningsresultater til ”butikk”</td>
</tr>
<tr>
<td>61.2 %</td>
<td>Trening i definisjon og analyse av sammensatte oppgaver, ”problemløsning”</td>
</tr>
<tr>
<td>36.3 %</td>
<td>Syntese av helhetlige løsninger, som kan dekke flere teknologiske og ikke-teknologiske fag</td>
</tr>
<tr>
<td>22.8 %</td>
<td>Trening i kreativt arbeid</td>
</tr>
<tr>
<td>36.2 %</td>
<td>Trening i vurdering av beregninger og resultater</td>
</tr>
<tr>
<td>22.7 %</td>
<td>Trening i å lede og motivere medarbeidere</td>
</tr>
<tr>
<td>40.2 %</td>
<td>Trening i gruppearbeid og kommunikasjon</td>
</tr>
<tr>
<td>16.5 %</td>
<td>Arbeidslivspraksis som gir trening i ingeniørfaglig arbeid og styrker evnen til samarbeid med andre yrkesgrupper</td>
</tr>
</tbody>
</table>

**9. Hvilke ikke-teknologiske emner har du selv hatt utdanning i (kryss av alle relevante)?**

<table>
<thead>
<tr>
<th>Andel</th>
<th>Emner</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.8 %</td>
<td>Arbeid i team (tverrfaglighet, samarbeid, håndtering av konflikter)</td>
</tr>
<tr>
<td>39.2 %</td>
<td>Arbeids- og organisasjonspsykologi (motivasjon, læring, kommunikasjon)</td>
</tr>
<tr>
<td>2.1 %</td>
<td>Estetikk</td>
</tr>
<tr>
<td>52.0 %</td>
<td>Bedriftsøkonomi (investeringsanalyse, budsjettering, finansiering, økonomistyring)</td>
</tr>
<tr>
<td>8.9 %</td>
<td>Etikk (forretningsetikk, verdigrunnenlag, retfærdighet)</td>
</tr>
<tr>
<td>16.3 %</td>
<td>Formidling av kunnskap (teknologi, prosjekter, ideer)</td>
</tr>
<tr>
<td>7.9 %</td>
<td>Globalisering (kulturforskjeller, nasjonal og internasjonal politikk)</td>
</tr>
<tr>
<td>38.9 %</td>
<td>Helse, miljø og sikkerhet (partene i arbeidslivet, arbeidsmiljø, sikkerhet)</td>
</tr>
<tr>
<td>5.7 %</td>
<td>Industriell økologi (livsløpsanalyse, material- og energistrømsanalyse, økodesign)</td>
</tr>
<tr>
<td>21.9 %</td>
<td>Juridiske emner (arbeidsrett, kontraktsrett, opphavsrett)</td>
</tr>
<tr>
<td>7.8 %</td>
<td>Filosofi</td>
</tr>
<tr>
<td>Emne</td>
<td>Andel</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Markedsføring (salg, strategi, verdikjeder, nettverk)</td>
<td>16.7%</td>
</tr>
<tr>
<td>Næringsutvikling (innovasjon, nyskaping, entreprenørskap, næringspolitikk, produktdesign)</td>
<td>7.3%</td>
</tr>
<tr>
<td>Organisasjon og ledelse (prosjektledelse, organisasjonsutvikling, kunnskapsutvikling og læring, IKT og organisasjoner)</td>
<td>58.3%</td>
</tr>
<tr>
<td>Samfunnsøkonomi</td>
<td>18.9%</td>
</tr>
<tr>
<td>Språk (fremmedspråk: engelsk, tysk, fransk, spansk, russisk, japansk el. annet)</td>
<td>27.6%</td>
</tr>
<tr>
<td>Teknologi- og næringshistorie</td>
<td>4.7%</td>
</tr>
<tr>
<td>Ikke svart</td>
<td>5.5%</td>
</tr>
</tbody>
</table>

10. Hva mener du om andel ikke-teknologiske emner i din utdanning fra NTH/NTNU (kryss av for 1 alternativ)?

<table>
<thead>
<tr>
<th>Andel</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Altfor lite</td>
<td>13.4%</td>
</tr>
<tr>
<td>Passe omfang, men feil tema</td>
<td>12.7%</td>
</tr>
<tr>
<td>Passe omfang, hensiktsmessige tema</td>
<td>23.8%</td>
</tr>
<tr>
<td>Passe omfang, hensiktsmessige tema, men kom for tidlig i studiet</td>
<td>11.0%</td>
</tr>
<tr>
<td>Hensiktsmessige tema, men for lite omfang</td>
<td>7.0%</td>
</tr>
<tr>
<td>Viktige tema manglet</td>
<td>13.9%</td>
</tr>
<tr>
<td>Viktige tema manglet, burde vært større omfang</td>
<td>13.9%</td>
</tr>
<tr>
<td>Altfor mye</td>
<td>2.4%</td>
</tr>
<tr>
<td>Ikke svart</td>
<td>1.9%</td>
</tr>
</tbody>
</table>

11. Hva opplever du å være de viktigste målsettingene med det å ha ikke-teknologiske emner i siv.ing.-utdanningen (3 alternativer)?

<table>
<thead>
<tr>
<th>Andel</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sette eget fag i et videre perspektiv</td>
<td>64.6%</td>
</tr>
<tr>
<td>Lære mer om konsekvenser av teknologi</td>
<td>30.5%</td>
</tr>
<tr>
<td>Øke selvinnsikten</td>
<td>19.0%</td>
</tr>
<tr>
<td>Øke forståelsens for andre disipliner</td>
<td>47.2%</td>
</tr>
<tr>
<td>Kompletttere den faglige kompetansen</td>
<td>55.2%</td>
</tr>
<tr>
<td>Utvide jobbvalgmulighetene</td>
<td>9.8%</td>
</tr>
<tr>
<td>Gi sivilingeniøren en mer ikke-teknologisk fagprofil</td>
<td>10.4%</td>
</tr>
<tr>
<td>Forutsetning for å påta seg lederoppgaver</td>
<td>45.6%</td>
</tr>
</tbody>
</table>

12. Hvilke ikke-teknologiske temaer har vært sentrale for deg i din yrkesutøvelse som sivilingeniør (kryss av 5 alternativer)?

<table>
<thead>
<tr>
<th>Andel</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Arbeid i team (tverrfaglighet, samarbeid, håndtering av konflikter)</td>
<td>81.4%</td>
</tr>
<tr>
<td>Arbeids- og organisasjonspsykologi (motivasjon, læring, kommunikasjon)</td>
<td>41.9%</td>
</tr>
<tr>
<td>Estetikk</td>
<td>4.8%</td>
</tr>
<tr>
<td>Bedriftsøkonomi (investeringsanalyse, budsjettering, finansiering, økonomistyring)</td>
<td>42.4%</td>
</tr>
<tr>
<td>Etikk (forretningsetikk, verdigrunnlag, rettferdighet)</td>
<td>11.5%</td>
</tr>
<tr>
<td>Formidling av kunnskap (teknologi, prosjekter, ideer)</td>
<td>56.5%</td>
</tr>
<tr>
<td>Tema</td>
<td>Andel</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Globalisering (kulturforskjeller, nasjonal og internasjonal politikk)</td>
<td>10.7 %</td>
</tr>
<tr>
<td>Helse, miljø og sikkerhet (partene i arbeidslivet, arbeidsmiljø, sikkerhet)</td>
<td>35.1 %</td>
</tr>
<tr>
<td>Industriell økologi (livsløpsanalyse, material- og energistrømsanalyse, økodesign)</td>
<td>3.4 %</td>
</tr>
<tr>
<td>Juridisk emner (arbeidsrett, kontraktsrett, opphavsrett)</td>
<td>22.5 %</td>
</tr>
<tr>
<td>Filosofi</td>
<td>1.1 %</td>
</tr>
<tr>
<td>Markedsføring (salg, strategi, verdikjeder, nettverk)</td>
<td>27.0 %</td>
</tr>
<tr>
<td>Næringsutvikling (innovasjon, nyskaping, entreprenørskap, næringspolitikk, produktdesign)</td>
<td>15.7 %</td>
</tr>
<tr>
<td>Organisasjon og ledelse (prosjektledelse, organisasjonsutvikling, kunnskapsutvikling og læring, IKT og organisasjoner)</td>
<td>64.6 %</td>
</tr>
<tr>
<td>Samfunnsøkonomi</td>
<td>5.6 %</td>
</tr>
<tr>
<td>Språk (fremmedspråk: engelsk, tysk, fransk, spansk, russisk, japansk el. annet)</td>
<td>40.4 %</td>
</tr>
<tr>
<td>Teknologi- og næringshistorie</td>
<td>2.1 %</td>
</tr>
<tr>
<td>Annet</td>
<td>7.3 %</td>
</tr>
</tbody>
</table>

13. **I hvor stor grad synes du ikke-teknologiske temaer i siv.ing.-studiet bør gis?**

<table>
<thead>
<tr>
<th>Tema</th>
<th>Andel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kun som integrerte tema i de ordinære siv.ing.-emnene</td>
<td>4.8 %</td>
</tr>
<tr>
<td>Hovedsakelig som integrerte tema i ordinære emner, men med noen rene ikke-teknologiske emner</td>
<td>34.0 %</td>
</tr>
<tr>
<td>Hovedsakelig som egne emner, men med noe integrert i ordinære siv.ing.-emner</td>
<td>53.0 %</td>
</tr>
<tr>
<td>Kun som egne emner</td>
<td>6.9 %</td>
</tr>
</tbody>
</table>

14. **Hvilke emner kunne du tenke deg å ta som etter- og videreutdanning (kryss av 5 alternativer)?**

<table>
<thead>
<tr>
<th>Tema</th>
<th>Andel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arbeid i team (tverrflagighet, samarbeid, håndtering av konflikter)</td>
<td>41.2 %</td>
</tr>
<tr>
<td>Arbeids- og organisasjonspsykologi (motivasjon, læring, kommunikasjon)</td>
<td>45.3 %</td>
</tr>
<tr>
<td>Estetikk</td>
<td>6.2 %</td>
</tr>
<tr>
<td>Bedriftsøkonomi (investeringsanalyse, budsjettering, finansiering, økonomistyring)</td>
<td>45.2 %</td>
</tr>
<tr>
<td>Etikk (forretningsetikk, verdigrunnlag, rettferdighet)</td>
<td>11.6 %</td>
</tr>
<tr>
<td>Formidling av kunnskap (teknologi, prosjekter, ideer)</td>
<td>38.8 %</td>
</tr>
<tr>
<td>Globalisering (kulturforskjeller, nasjonal og internasjonal politikk)</td>
<td>21.9 %</td>
</tr>
<tr>
<td>Helse, miljø og sikkerhet (partene i arbeidslivet, arbeidsmiljø, sikkerhet)</td>
<td>14.4 %</td>
</tr>
<tr>
<td>Industriell økologi (livsløpsanalyse, material- og energistrømsanalyse, økodesign)</td>
<td>12.6 %</td>
</tr>
<tr>
<td>Juridisk emner (arbeidsrett, kontraktsrett, opphavsrett)</td>
<td>30.2 %</td>
</tr>
<tr>
<td>Filosofi</td>
<td>10.7 %</td>
</tr>
<tr>
<td>Markedsføring (salg, strategi, verdikjeder, nettverk)</td>
<td>26.6 %</td>
</tr>
<tr>
<td>Næringsutvikling(innovasjon, nyskaping, entreprenørskap, næringspolitikk, produktdesign)</td>
<td>31.7 %</td>
</tr>
<tr>
<td>Emne</td>
<td>Andel</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Organisasjon og ledelse (prosjektledelse, organisasjonsutvikling,</td>
<td>57.6%</td>
</tr>
<tr>
<td>kunnskapsutvikling og læring, IKT og organisasjoner)</td>
<td></td>
</tr>
<tr>
<td>Samfunnsøkonomi</td>
<td>12.9%</td>
</tr>
<tr>
<td>Språk (fremmedspråk: engelsk, tysk, fransk, spansk, russisk, japansk</td>
<td>38.7%</td>
</tr>
<tr>
<td>el. annet)</td>
<td></td>
</tr>
<tr>
<td>Teknologi- og næringshistorie</td>
<td>8.6%</td>
</tr>
</tbody>
</table>

| 15. Når i studiet synes du at de ikke-teknologiske emnene bør        | Andel  |
| komme?                                                              |        |
| Streng gjennom hele studiet (jevnt fordelt)                         | 45.3%  |
| Andre til fjerde år                                                 | 15.8%  |
| Andre til femte år                                                  | 10.8%  |
| Tredje til femte år                                                 | 26.6%  |

| 16. Ikke-teknologiske emner utgjør i dag 10 % (totalt ett semester) | Andel  |
| av siv.ing.-studiet. Synes du at dette?                            |        |
| Bør økes                                                           | 30.5%  |
| Er et passe omfang                                                 | 62.6%  |
| Bør reduseres                                                      | 5.4%   |

| 17. Åpent spørsmål: Hvis andelen ikke-teknologiske emner skal økes,  | Andel  |
| hva mener du i så fall det skal reduseres på?                      |        |
| (se oppsummering nedenfor)                                         |        |
| Noen obligatoriske, noen felles anbefalte, valgbare               | 54.3%  |
| Alle felles anbefalte, valgbare                                    | 5.8%   |
| Anbefalte pakker pr. studieprogram med valgfrihet                  | 26.8%  |
| Obligatoriske pakker pr. studieprogram                             | 4.5%   |
| Helt fritt valg innenfor NTNU-emner                                | 7.4%   |

| 19. Åpent spørsmål: Hvilken ikke-teknologisk kompetanse har du hatt | Andel  |
| mest bruk for i din praksis (angi 1 emne)?                         |        |
| (se oppsummering nedenfor)                                         |        |
| 20. Åpent spørsmål: Andre kommentarer? (se oppsummering nedenfor)  |        |
QUALITY ASSURANCE

of

TEACHING AND LEARNING

at

the Norwegian University of Science and Technology (NTNU)

Recommendation from the Committee for Quality Assurance at NTNU
13 November 2003
QUALITY ASSURANCE OF TEACHING AND LEARNING AT NTNU

1. Introduction

1.1. Committee and work method
The Committee for Quality Assurance at NTNU (UKS) was appointed by the Project Steering Committee for Quality Reform at NTNU at a meeting on 13 June 2002. The committee has a mandate until 31 December 2003, and comprises Professor Per Morten Schiefloe (chair), Professor Asbjørn Aune, Assistant Professor Geir Halland, Vice Rector Kjell Malvig, Professor Stefan Hopmann, Faculty Director Gunnar Parelius, Professor Tor A. Åfarli, student Christine Nynes Stromhylden until 31 December 2002, student Stian Simensen until 31 December 2002, student Åge Halvorsen from 1 January 2003 and student Hanne S. Pedersen from 1 January 2003. The secretary of the committee until the summer of 2003 was adviser Kristin Grimstad from the Organizational Division. This function was taken over by senior advisor Per Kjøl from the same division.

The committee submitted its first recommendation in May 2003. At a meeting held on 22 May 2003, the steering committee agreed that further work with the quality assurance system should take place on the basis of the principles in this recommendation. A prerequisite stipulated by the steering committee was participation by the units in further specification and implementation. Accordingly, the recommendation was distributed for comments. On the basis of comments received, UKS has provided certain clarifications and corrections in its final recommendation.

1.2. Objective
The objective of the quality assurance system is to bring about improvements through feedback and accountability. The quality assurance system has therefore been designed to focus on key aspects that influence quality in the study process and the support processes. A major challenge is to ensure consistency and coordination between different courses. The system is to help to reduce the number of non-conformances and "firefighting" activities that need to be handled at present. After the implementation phase and in the longer term, the system should thus result in savings. In the development and implementation phase, however, extra resources will be needed in the form of staffing, competence and funding for particular tasks.

Here, "study process" refers to the process from the admission of a student to NTNU until completion of the programme of study and certification to enter the working world. This can be represented as follows:
The figure shows that the study process begins with the student's admission to NTNU and ends when the student enters the working world. The arrow from the working world back to the teaching activities indicates the interaction of the teaching with the needs of the working world.

The student is admitted to a programme of study, but can later specialize by selecting a particular field. The programme of study, fields of study, and individual courses are described in a curriculum/handbook.

This document concentrates on quality assurance of teaching and certification activities.

The quality assurance system imposes requirements for the development of explicit objectives for each programme of study, course, and teaching initiative, against which outcomes are to be measured. Requirements are imposed for routines to monitor the implementation and for routines for the measurement of outcomes. The quality assurance system assigns responsibility for implementation and follow-up.

2. General principles

The following principles form the basis for the development of the quality assurance system:

- The primary objective of the quality assurance is not control, but improvement. Reporting is to take place in a way that fulfils this objective.

- The quality system is to be embedded in NTNU’s overarching objectives, and forms an important part of the management and governing system at NTNU.

- The quality system is to be simple, robust and unbureaucratic.

- The quality system is to ensure the quality of the processes that are important in and for the study programmes.
• Routines for quality assurance, quality enhancement and evaluation are to be a natural and integrated part of the teaching activities at NTNU.

• The quality system defines the processes subject to quality assurance and describes the tasks to be performed. It assigns responsibility for both implementation and follow-up.

• A common framework and requirements include the elements common to the whole of NTNU. Criteria and measurement methods must be developed in relation to the academic cultures, and the academic environments must participate actively in the development of criteria for their own courses and programmes of study. While key requirements are to be set for what is to be done, how it is to be done is, to a great extent, up to the academic communities.

• Every time a programme is completed or a course is taught, it is regarded as an independent project with four phases: Planning, implementation, assessment of the achievement of objectives and quality, and improvement/adjustment.

![Diagram of the project approach]

The various phases will be completed every time to ensure continuous improvement and renewal.

Routines will also be developed to ensure the quality of the various support processes influencing students' total study process. The requirements for these are described in Section 7.

There may be tensions between some of the principles, and the challenge is to find a good balance between:

• standardized common solutions and local solutions when the necessary tools are to be designed

• unbureaucratic, simple and robust systems on the one hand, and the necessary reporting and requirements for forums for planning and follow-up on the other.

2. 1. Project approach

To prevent the teaching activities from becoming a continuous repetitive routine, the annual implementation of each programme of study and each course is to be regarded
as an independent project with a defined start and end. The practical organization must however be adapted to the complexity of the course/programme and the number of contributors.

When more than one person takes part in the teaching, a project group is to be established. The project group includes those who have an active responsibility for the teaching of the course. The group is headed by the course coordinator. If the course coordinator is alone in the implementation, he or she performs the relevant tasks of the project group. In addition, a reference group is to be created with a selection of students.

The four project phases are completed every time the course is taught or the programme is implemented, cf. the model:

- In the planning phase, the project objectives are formulated and the methods are specified.
- In the implementation phase, regular meetings are held in the project group and with the reference group to check that the progress and direction are in accordance with the plans.
- When the course has been completed, the outcomes and achievement of objectives are assessed so that improvements and adjustments can be made.

A key aspect of the quality activities is to ensure academic and educational renewal and development. This is an important responsibility for faculties, the management of the study programmes, and departments.

2. 2. Assignment of responsibility
The responsibility for the introduction of the quality system and for adapting it to local conditions within the approved framework is a line responsibility, that is, a responsibility for deans, faculty directors, and heads of departments.

The responsibility for following the routines is assigned to the individual course coordinators and to the management of the study programme for each programme of study. To achieve the objectives described in curricula and semester plans, the study programme councils must have substantial influence on implementation and follow-up.

The immediate line manager is responsible for following up performance of the routines, and must also ensure that corrective measures are initiated when nonconformities in quality are revealed.

2. 3. Reporting
The standards and criteria against which quality is measured – which are defined in the planning phase – are to be published in the curricula and semester plans. Performance of the quality assurance routines is documented in a documentation database. No plans have been made for underlying units to produce outcome reports beyond the quantitative data that other systems can already produce at the various management levels.
The objective of the quality assurance is not control, but development and improvement. Each level and each unit evaluates the factors that it can influence itself. Reporting is to be submitted to and dealt with by the parties that it concerns. Quality is not achieved through final inspection, but through well-established routines and a quality-conscious culture.

On the basis of its legitimate needs in relation to NOKUT's criteria, the top level must be able to generate reports showing whether the quality assurance has been performed in accordance with the requirements in the system. To enable monitoring of the trend in quality over time, data may be retrieved from the documentation database to show, for example, the use of various teaching methods and forms of assessment.

3. Quality assurance of individual courses

Note that the Regulations for studies at NTNU stipulate more detailed rules for some of these points.

3.1. Planning

In the planning phase, the objectives for the course are to be formulated and the methods are to be determined. The results from the planning phase are documented in the curriculum and semester plan. In addition, the support system will need to receive orders from the planning phase within given time limits. The time aspect is important in this phase, and must be resolved with the support system and any other participants. The semester plan is to be communicated to the students.

Course coordinator

The head of department/faculty management is to ensure that each course has a course coordinator. The course coordinator is responsible for quality assurance of the course in accordance with the regulations. The course coordinator convenes meetings with the project group.

Objectives for the course

All courses are to have a clear description of the objective of the course. Learning objectives are to be specified as:

- Product objectives: knowledge, skills and attitudes
- Process objectives: that is, how the student should benefit from the work method, for example, by developing a capacity for critical thinking or learning a particular study technique.
- Production objectives in the form of the number of credits or graduates.

Scope of work

To create parity between credits in different courses and determine a reasonable workload for the full-time student, the work volume in the individual course is to be standardized. The basis for the planning is to be a workload corresponding to 30 working hours (gross) per credit. The point of departure for the calculation is the average time that it is assumed a student will need to achieve the learning and process objectives in an appropriate way.

The calculated workload is to cover all activities related to the course, such as:
- lectures
- exercises
- laboratory work
- seminars
- training in methods
- excursions
- fieldwork
- various written assignments, such as group assignments
- artistic performances/exhibitions
- project work
- self-study
- final examination and other assessments

The distribution of the calculated workload between the various learning activities within the course is to be described.

**Prerequisites**
The curriculum must communicate the prerequisites that the student needs in order to be able to complete the course.

**Academic context**
The course must be assessed in the context of other courses to ensure reasonable progress for the student. The management of the programme of study is responsible for establishing the relationship between the courses in the programme.

The course is to be rooted in research, that is, the teaching is to be based on existing knowledge within the discipline in that it includes and communicates the results of its own and/or others' research.

**Capacity and resources**
The programme is to be adapted to the resources available in collaboration with the head of the department and the management of the study programme. The course coordinator takes responsibility for reporting staffing requirements such as the need for technical staff, teaching assistants, etc.

When staff are allocated, the course coordinator assigns them to the teaching schedule.

**Teaching method**
The semester plan specifies and describes the teaching activities included in the course, which activities are compulsory, and the schedule for the various activities.

The course coordinator reports needs for infrastructure as well as teaching materials and media to the department administration, library, bookshop, Technical Division, etc. The time limit for such feedback is to be arranged with the support system.

**Form of assessment (examination)**
The form of assessment is to be adapted to the objective of the course. The assessment is an integral part of the learning process.
Testing of the students' skills and knowledge is to give them an opportunity to demonstrate an understanding of relationships and a capacity for critical reflection, including reflection on their own attitudes.

In the choice of the form of assessment, the following factors must be taken into account and conveyed:
- the academic requirements that apply
- the time and duration of the assessment
- whether the assessment is to be individual or group-based
- which aids are allowed

**Learning process**
Staff need to consider how the course arrangements can best be adapted to ensure an effective learning process for the students. Elements in such an assessment will be:
- academic progress
- time usage
- choice of various educational methods

### 3.2. Implementation

**Project meetings/follow-up meetings**
Follow-up meetings are to be held to ensure that the progress and direction comply with the planned objectives. The purpose is to be able to identify nonconformities rapidly to enable the necessary corrections along the way. Meetings are held as frequently as needed, but at least once per semester. If necessary, the objectives established in the semester plan can be adjusted in the light of the experience gained.

The meetings are conducted with reference groups of students and, for example, teaching assistants, technical staff, and course lecturers.

**Continuous evaluation**
An evaluation system is to be drawn up in order to obtain feedback from the students along the way. The scope and method are to be adapted to the course. The reference group/representatives of the students participate in the evaluation.

The aim of continuous evaluation is to evaluate the extent to which the teaching process is yielding the desired outcomes. Continuous evaluation creates opportunities for to make improvements immediately. Such evaluation can also generate ideas and innovative development that are not realized immediately, but that are taken care of and implemented in the next project, that is, the next time that the course starts.

The quality system includes a set of standard tools.

At regular intervals, and at least every third year, a more extensive evaluation is to be conducted. This may be included in a larger programme evaluation, cf. Section 4.3.

### 3.3. Assessment of achievement of objectives and quality

When the course has been completed, the person with the academic responsibility is to assess whether the objectives for the course have been achieved.
3.4. Improvement and adjustments
The head of the department/line manager is to ensure that evaluation and assessment of results takes place, and is responsible for the academic and educational standard of each course.

To ensure that experience is preserved, that reflection on outcomes takes place, and that this results in continuous improvement, the results of evaluation and measurement must be followed up through an action plan if necessary. The action plan is to focus on both academic and educational aspects.

The head of the department/line manager is responsible for following up and arranging further development of the teaching staff. Teaching and academic guidance is to be made available to the teaching staff as needed.

4. Quality assurance of programmes of study
Note that the Regulations for studies at NTNU stipulate more detailed rules for some of these points.

4.1. Planning
Control and organization
The dean is to ensure that all programmes of study have a responsible coordinating management (management for the programme of study) with a clear mandate and authority to take care of the programme as a whole and its relevance.

Responsibilities of the management of the study programme:
- take academic responsibility for the programme
- define resource requirements
- allocate resources
- regularly assess the whole programme and the individual courses
- market the programme of study
- participate actively in recruiting students,
- maintain regular contact with the outside world
- assess market needs and demand

Responsibilities of the departments and arenas:
- provide resources for the teaching of the individual courses
- develop the staff and competence profile
- ensure the academic development of their own teaching staff

Changes in access to resources and working life
The management of the study programme is responsible for handling changes in fields of study, the course portfolio, and the course content, as well as for ensuring the best possible consistency between the academic subjects and fields offered and the current and anticipated future needs of the labour market and of society.

Establishment of new programmes of study, extensive changes or termination of programmes are to be decided by the University Board.

Objectives for the programmes of study
All programmes of study are to have defined objectives. The management of the study programme is to draw up objectives describing:

- the type of competence that graduates should have
- the type of duties (for example: careers/professions/work) for which the programme of study represents a qualification

**Basic competence**
The basic competence that the programme of study is to provide must be defined in the light of the specified objectives. The management of the study programme is to:

- Decide/recommend which fields of study/specializations the programme is to include and how it is to be differentiated
- determine how many specializations are to be included in relation to the teaching capacity, student market, needs, and what it is possible to coordinate
- specify the stage in the studies from which the differentiation is to apply
- decide how much freedom students are to be given to compose their own programme of study

**Detail**
In specifying the details of the programme of study, the management for the study shall:

- decide which courses are to be included in the programme of study
- be responsible for coordination between the programme of study and the courses
- ensure that the courses are coordinated throughout the semester (with regard to time schedule and workload)
- coordinate and conduct an assessment of teaching methods, content, assignments and assessment forms as a whole within each semester
- ensure progression through the programme of study
- take care of the academic interrelationships between the various courses

**Composition of subjects**
The management for the programme of study determines the academic composition of the programme on the basis of the following criteria:

- academic requirements
- occupational relevance
- relevance for the individual student
- making allowance for choices through the size of the programme and by offering guidance

**The relationship between courses**
The management of the study programme is to take care of the relationship between the courses by ensuring:

- academic progress
- horizontal coordination
- interfaces, that is, transitions between the courses

**4.2. Implementation**
Project meetings/follow-up meetings
Follow-up meetings are to be held to check progress and direction in relation to the objectives that have been formulated in the planning phase. The management of the study programme conducts such meetings with course coordinators and reference groups consisting of students and, for example, teaching assistants, technical staff and course lecturers. The result of the continuous evaluation (cf. next paragraph) will provide important information for the follow-up meetings.

**Continuous evaluation**

An evaluation system is to be developed in order to obtain continuous feedback. The management of the study programme ensures that the ongoing feedback reports are coordinated so that the work that this entails for the students is distributed throughout the semester in a reasonable way.

**4.3. Assessment of achievement of objectives and quality**

After completion of the programme of study, the programme management is to assess whether the objectives of the programme have been achieved.

External assessments/evaluations will be conducted at regular intervals to measure the quality of the programme of study and to ensure consistency and progression between the individual courses.

**4.4. Improvement and adjustment**

To ensure that experience is taken care of, that reflection on outcomes takes place, and that this results in continuous improvement, the results of continuous evaluation and measurement must be followed up. After the potential for improvement has been identified, solutions are to be developed, and an action plan with specified priorities is to be drawn up.

In collaboration with the management of the department/faculty, the study programme management is to follow up the improvement efforts.

**5. Assessment of the students' level of knowledge**

Note that the *Regulations for studies at NTNU* stipulate more detailed rules for some of these points.

**5.1 Form of assessment**

In the planning of the course, the forms of assessment are to be determined (cf. 2.1). The form of assessment is based on the competence that the students are to achieve, and forms an integral part of the learning process.

**5.2 Assessment criteria**

If no external examiner takes part in the assessment of the students' performance, external monitoring of the assessment systems themselves is to be implemented. Each faculty decides how external participation in the assessment is to be accomplished.

Clear criteria are to be set for the assessment of the students' performance. These are to be communicated to the students and to describe the following elements, among others:

- formal requirements for written assignments
- which of the learning activities are to be assessed continuously and taken into account in the grade
- how any partial assessments are weighted

5.3 Final examinations
The academic departments are to develop routines for quality assurance of examination questions.

In connection with the individual examination questions, a guide for marking is to be prepared.

When there are several boards of examiners, the distribution of grades is to be checked.

The management of the study programme monitors the trend in the distribution of grades within the individual courses and for the programme of study as a whole over time.

6. Tools and aids - follow-up and development
The department and faculty management is to arrange for development of educational competence for the teaching staff and ensure that good teaching is recognized.

To assist the academic coordinators and study programme management in the planning and implementation of the teaching, the system is to include a variety of tools and support systems.

6.1. Toolbox and documentation database
A toolbox is to be created, containing checklists, templates, and guides for the various activities in the teaching and learning process. The toolbox includes both the standard variants and locally customized versions. The toolbox is to be made available to course coordinators and programme coordinators via the Web.

- **System responsibility**: A staff division is assigned system responsibility. This includes procurement, operation and development of the computer tool itself, the "rules of the game", and training of the users.
- **Process owners**: The system includes teaching and supporting processes to which the tools are linked. The responsibility for the individual processes with the associated tools must be unambiguous. The process owners describe and document the process; they develop and refine the standard tools in the light of experience. Process ownership is assigned on the basis of influence over the process, organizational position, authority and competence.

6.2. Evaluation of learning activities
The following aspects, among others, are surveyed through various forms of student evaluation:
- Educational methods and implementation
- communication with the students
- development of involvement and motivation
- the students' learning activities and progress
6.3. Guidance service for teaching methods
If any need for assistance to the course coordinator or others is identified, the academic management at department and programme level is responsible for initiating action.

To enable assistance to teaching staff and academic management in the quality enhancement work and the implementation of improvement measures, NTNU offers a guidance service in university teaching methods. This teaching service provides assistance in various areas: individual guidance to teaching staff, assistance in educational technology, planning, training in various educational methods, systems and quality assurance for the evaluation of teaching.

The service should be seen in the context of the compulsory basic training in university teaching, and forms part of the university education methods environment at NTNU. Assistance to management and teaching staff is to be based on demand, and the service is to function as a resource for them.

6.4. Students' responsibilities
Students are obliged to take part in the specified evaluation of a course.

7. Quality assurance of support systems
The same approach to quality is to form the basis of the support systems. The key support systems with regard to teaching are:

- supervision of studies
- general information
- student welfare
- student service
- infrastructure for the students (rooms, equipment, IT)
- library
- Student and Academic Division
- registration for examinations and examination sessions
- allocation and use of rooms
- laboratory and workshop services (including IT/PC rooms)
- office support, administrative services

The future organization is to be process-oriented, centred on customers and users. Those who are responsible for the support systems must therefore ensure a continuous and effective dialogue with users of the service. Those responsible for the support systems are to:

- chart and document their work processes and dependencies
- set up objectives for the service and publish these
- define criteria for quality measurement
- undertake evaluations of their own service
- initiate corrective actions on the basis of the results of the evaluations

The head of the unit in question is responsible for ensuring that these points are implemented systematically.
Appendix

Glossary

Assessment
The feedback provided to a student on his or her performance in a course or a course combination, and that results in a grade.

Certification
Here: the final assessment of students after the completion of their studies, which reflects the extent to which the student is capable of providing the competence needed by the labour market and by society.

Course
The smallest unit in which a student can be assessed and that results in a grade. The extent of the course is measured in credits. The course includes activities that can form the basis for assessment. The activities may be compulsory.

Course coordinator
The lecturer with the primary responsibility for the teaching of a course.

Curriculum
Description of the objectives, content and arrangements for programmes of study, fields of study and courses.

Evaluation
Assessment of whether a process (here: the teaching) is academically and educationally satisfactory.

Field of study
An academic specialization within a programme of study, described in the curriculum for the programme of study.

Programme of study
A set of courses that forms a whole study, to which students are admitted and granted the right to study, and that leads to a degree.

Quality assurance
Planned and systematic activities undertaken to ensure that the requirements for quality are met.

Quality assurance system
Description of approved requirements, procedures, routines and assignment of responsibility for the quality assurance activities.

Semester plan
Activity description for the teaching of a course. A semester plan applies to a given semester for a defined student/student group, and includes forms of work and the schedule for the various activities, among others.

Study programme management
The governing body for a programme of study.
Chapter 1 Scope, Purpose and Definitions

1 Scope and Purpose
1. The regulations are valid for all studies at the Norwegian University of Science and Technology (NTNU).

2. The regulations contain rules about the organization of studies, examinations and assessment, requirements for the award of degrees, and regulations concerning the rights and obligations of the University and students at NTNU. The regulations are to ensure that studies and examinations at NTNU are carried out properly.

2 Definitions
Final examination A type of assessment that normally follows at the end of the semester under conditions that can be controlled. The final examination generally is the concluding assessment of the student in a course or a group of courses.

Course The smallest unit in which the student can receive an assessment and course grade. The extent of the course is measured in credits. The course involves activities that form the basis for assessment. The activities may be compulsory.

Subject A collection of courses in one group in a curriculum.

Main profile Courses in a curriculum which are defined as belonging to the same discipline which can supplement each other and build on foundation course level in a programme of study. In case a Master’s degree is based on a completed Bachelor’s degree, the main profile contains the academic qualifications required for admission to the Master’s degree.

final grade The grade given after a course or group of courses. It is based on the assessments that count during that course. The weighting of the grades in assessments during the course is stated in the course description.

Credits Measure of the study workload. The normal workload in one academic year is 60 credits.

Programme of study A group of courses that forms one academic entity that students can apply for admission to, receive the right to study, and leads to a degree.

Field of study A specialization within a programme of study, which is described in the curriculum for that programme of study.

Assessment The evaluations a student receives on the basis of his/her performance in a course, or a group of courses and that lead to a grade.

One-year programme A structured group of courses totalling 60 credits and having separate admission.
These regulations refer to the Act relating to Universities and University Colleges of 1 April 2005, no. 15.

Chapter 2 Admission and individual education plan

3 Admission
The valid admission regulations are the relevant regulations adopted by the Ministry of Education and Research and NTNU’s own admission regulations.

4 Admission to study and progress in studies
1. Admission involves the right to take the courses in the programme of study, a one-year programme or separate courses which the student has gained admission to. Admission provides the opportunity to take the courses specified in the individual education plan or in accordance with the progress in studies approved by the Faculty. Admission to study is valid from the day NTNU receives confirmation of the student’s acceptance of his/her admission.

2. The right to take the programme of study which the student has been admitted to ceases when
   - the student fulfils the criteria allowing him/her to receive a certificate after completing the programme of study
   - the student has completed the one-year programme
   - the student’s progress in studies is insufficient, according to the definition given in Section 4, subsection 3
   - the student himself/herself confirms that he/she has withdrawn from the programme of study before it is completed
   - the student has not paid the semester fee by the stipulated deadline, see Section 6.

3. In programmes of study that are divided into year courses/years, a student cannot take the next year if he/she has an outstanding deficit of more than 22.5 credits from the two previous years. Students who want to take the 4th year cannot have any unfinished courses from the 1st year. Students who want to take the 5th year cannot have any unfinished courses from the 1st and 2nd years, and students who want to take the 6th year cannot have any unfinished courses from the 1st, 2nd, and 3rd years.

   The student loses the right to study a programme of study if he/she has an outstanding deficit of more than 22.5 credits. No student is permitted to use more than 2 academic years to take the same year in a programme of study. The time spent in each year should be adjusted according to any leave that has been granted, and any possible reductions in the study progress (part-time studies) that have been approved in the individual education plan, ref. Sections 5, 7, and 8.

   It is to be evident from the curriculum whether the programme of study is divided into years, ref. Section 14, subsection 1.

   Students that apply for re-admission to the same programme of study will, if applicable, be given recognition of previous studies in the year the student is admitted to. The same is true when there is great degree of similarity between a programme of study a student has applied for admission to and another programme of study a student has or had been admitted to. Exemption to this regulation can be made when more than three years have elapsed since the student was admitted to the other programme of study.

4. The Faculty is to decide whether the right to study should be terminated in accordance with the above regulations. The Faculty may grant exemptions from the regulations in Section 4, subsection 3 in cases of illness, serious family problems, when the main part of the studies has
already been completed, extraordinary conditions related to the subject (taking the next year) or other reasons found to warrant special treatment. Where the Board of NTNU has established an inter-Faculty board for a group of programmes of study, the latter board is authorized to reach decisions in cases related to exemptions.

5. A student who is not covered the regulations in Section 4, subsection 3 has admission withdrawn if he/she has not earned any credits during one academic year in the programme of study or one-year programme that the student is admitted to. This does not apply if the student has registered for and been present at one or more examinations and when it is agreed in the individual education plan that the student is not to earn any credits. The Faculty is to decide in matters of withdrawal of admission.

6. A student who has gained admission to a programme of study and has had normal progress (without adjustment for leave or reduced progress in studies), is not to be affected by changes in the disciplinary objectives, level and structure of the programme while completing his/her work on the programme. The student nevertheless has to accept that there may be changes in the courses and the structure of the programme of study that will not cause a delay in his/her progress.

7. A student who has gained admission to a programme of study, one-year programme or individual courses at NTNU, has the right to follow other courses he/she is qualified to take and receive assessment of his/her performance in these courses. The student also has the right to follow lectures in courses outside the programme of study or one-year programme if there are no restrictions on the admission to the courses. The student maintains these rights also after having completed the programme of study.

5 Individual education plan
The Faculty together with students who have gained admission to study for 60 credits or more are to agree on an individual education plan before the end of the first semester. The individual education plan can be amended in agreement with the Faculty. The individual education plan is a mutual agreement between the student and NTNU concerning the duties and responsibilities of each party for progress in studies as well as the duties and responsibilities of each student towards his/her fellow students. The individual education plan gives the content and progress of the planned studies, cf. Section 6, subsection 2.

6 Registration
1. Students who have been admitted to NTNU have to register and pay the semester fee at NTNU each semester by the deadline set by the Rector. The deadline is given in the curriculum and on NTNU’s Internet pages. Students who do not pay the semester fee by the stipulated deadline will have their admission withdrawn in accordance with the regulations relating to Student Welfare Organizations of 12 February 2001, Section 10. The Faculty is to decide in matters of withdrawal of admission due to non-payment of the semester fee.

2. For students who have agreed to an individual education plan, this registration is to determine and confirm the information in the plan for the current semester concerning
   - which courses the student will attend
   - which courses the student is to be given assessment in
   - other possible activities determined in the programme of study which the student follows
   - other information where adjustments are possible and which is relevant for the student’s progress in his/her studies.
3. Students who are not obliged to agree on an individual education plan or who have not yet entered into an individual education plan also have the duty to register. This registration is to indicate which courses the student will attend and receive assessment in.

4. The registration gives access to the resources offered by NTNU in order to enable the student to complete his/her courses that semester.

7 Leave of absence
1. The Faculty is to handle applications for leave of absence. Such leave from study is primarily given for one academic year. For shorter periods, leave can be given until the end on the semester. A student must have completed more than 30 credits in the courses included in the programme of study in order to apply for leave of absence without stating a reason.

2. The Faculty may accept an application for leave for more than one academic year if there are special circumstances or pressing reasons, such as illness, extensive demands for child-care etc., military service or civilian service.

3. The student must accept that there may be changes in the programme of study during a period when he/she has a leave of absence.

8 Part-time studies
Studies at NTNU may be taken on a part-time basis following agreement with the Faculty. The percentage of the nominal progress in studies is to be included in the individual education plan.

9 Students without the right to study
1. Those who have not been granted admission have the right to receive assessment in a course in accordance with the Act relating to Universities and University Colleges, Section 3-10. The Faculty decides whether the requirements for registration have been fulfilled and may specify further regulations concerning assessment in the absence of normal admission.

2. The Rector may decide upon a special deadline for registration for this type of assessment. The Rector can also decide that those who have not been admitted as students should pay an examination fee in order to cover the extra cost of carrying out such assessments.

10 Teaching – delegation of authority in accordance with the Act relating to Universities and University Colleges Section 3-8
1. The Faculty has the authority to reserve certain lectures just for the students of the University or specified groups of students if the nature of the lectures makes this necessary, cf. the Act relating to Universities and University Colleges Section 3-8, subsection 2.

2. The Faculty has the authority to allow people who are not following normal courses to attend lectures and participate in exercises whenever there is sufficient space.

11 Suspension, exclusion – delegation of authority in accordance with the Act relating to Universities and University Colleges Section 4-8, subsection 1
1. In cases where a student behaves in a way that seriously disturbs the work of fellow students or the general activities of the University, the Faculty has the authority to give a written warning stating that if such behaviour is continued a recommendation concerning suspension will be presented to the Board. In cases that are not specifically related to an individual Faculty, this authority rests with the Rector.
2. The Faculty has the authority to give a written warning to a student that an exclusion recommendation will be presented to the Board unless the suspension decision made by the Board is respected. In cases that are not specifically related to an individual Faculty, this authority rests with the Rector.

3. Complaints about decisions involving a written warning should be sent to the Appeals Committee at NTNU.

Chapter 3 Organization of studies

12 The academic year
1. The academic year consists of 40 weeks and is divided into two semesters. The autumn semester extends over 19 weeks and finishes before the end of the year. The spring semester lasts 21 weeks.

2. The Board of NTNU may approve that a programme of study at NTNU deviates from the ordinary structure described in Section12, subsection 1 if the duration of the programme is more than 40 weeks and has teaching and/or studies which can be pursued independently of the other studies at NTNU.

13 Programmes of study
1. Programmes of study at NTNU are organized according to the following models, they can
   - lead to a Bachelor’s degree which subsequently forms the basis for a Master’s degree.
   - be an integrated study which leads to a Master’s degree or a professional degree
   - lead to a Master’s degree which is based on a completed Bachelor’s degree or equivalent education.

   The Board establishes and terminates each programme of study at NTNU. When the Board creates a new programme of study, it should simultaneously decide which Faculty is to administer the programme.

2. Each programme of study has a main profile, which gives disciplinary specialization of at least 80 credits. All programmes of study involving 5-year integrated Master’s degrees should also satisfy the requirements of the Bachelor’s degree.

3. Each programme of studies consists of different courses. The courses offered should each be of 7.5 credits or a multiple of that. The courses given in the programme of study are either compulsory or optional. The Faculty establishes new courses and terminates old ones. When the Board at NTNU has created an inter-Faculty board for a group of programmes of study, this authority is vested in this board. The Board at NTNU is to approve the establishment of courses where it is assumed that this will increase the basic disbursement in the State appropriation model.

4. All programmes of study leading to a lower degree as well as integrated programmes of study leading to a higher degree or a professional degree are to contain three introductory courses:
   - Ex. phil. of 7.5 credits that is to be common for all students. Ex. phil. should ideally be a first semester course but this is not compulsory if there are academic grounds to do otherwise.
   - Ex. fac. of 7.5 credits is specific for the relevant Faculty. It should be part of the main profile and is to be taken in the first year.
   - Perspective course of 7.5 credits that is to represent a different field of study from that included in the student’s programme of study.
13a One-year programmes
The Rector is to establish and terminate each one-year programme at NTNU following a recommendation from the Education Committee. The rector is also to decide which Faculty is to administer each one-year programme.

14 Curriculum and course description
Each programme of study is to be described in a curriculum. The Faculty administering the programme of study is to approve the curriculum. Where an inter-Faculty board has been established by NTNU to cover a group of programmes of study, this board is responsible for compiling the curriculum. The curriculum should contain information about possible admission requirements and ranking regulations for the programme of study. The curriculum should stipulate:

- the learning outcomes and professional objectives of the programme of study
- any required previous knowledge for the programme of study
- which Faculty is to administer the programme of study
- which courses are included in the programme of study
- the scope of the programme of study in terms of credits
- what course combination meets the required main profile
- the structure of the programme of study, whether the programme of study has been divided into years, the fields of study, which are the common courses, which are compulsory and optional courses, and the sequence of the courses
- the possibilities for student exchanges abroad
- other issues which affect the implementation and quality assurance
- transitional arrangements as a result of changes in the curriculum.

All courses are to be presented in a course description. Each Faculty is to provide a description of its own subject areas. Each course description should include:

learning outcomes
the qualifications necessary to gain admission to the course
the content of the course
teaching methods
how many credits the course is worth
the extent of the education
possible compulsory education
which activities are included, their extent and which of them are compulsory, for instance courses in methodology, exercises, work experience, field courses, excursions, laboratory work, group exercises, semester papers and other written exercises, artistic performances
the requirements for receiving assessment
activities that will be subject to on-going assessment and which of them will count in the course grade
the organization of a possible final examination (how often, when in the semester, date and similar information)
what examination support material can be used
the form of assessment and grading scale for the assessments during the course
the weighting of assessments during the course that are to count in the course grade

15 Recognition of external studies/practical experience
1. The Faculty is to handle applications concerning recognition of external studies or practical experience in accordance with the Act relating to Universities and University Colleges Sections 3-4 and 3-5. A condition is that the external education has been approved as education at university or university college level.

2. The Faculty is to handle applications concerning the approval of an equivalent degree or education in accordance with the Act relating to Universities and University Colleges Section 3-4 subsection 3.

16 Exemption from assessment
1. The Faculty is to grant exemption from the final examination, test or other assessment in cases where the student can document that similar assessment has already been done by NTNU or another institution. The Faculty may also grant exemption on basis of other recognized examinations, tests or other kinds of assessment, or on basis of documented practical experience, in accordance with the Act relating to Universities and University Colleges Section 3-5. When processing such applications for exemption, the Faculty should take both a student’s previous education into account, as well as the assessment in terms of level, scope and content.

2. The student is to send such an application to the Faculty that administers the programme of study in which he/she has the right to study.

17 Reduction of credits
If a student receives assessment in courses where the content wholly or partially overlaps, the total of credits for these courses should be reduced accordingly. The Faculty decides the extent of the reduction in each separate case. If some of the courses to which the student has gained admission to are compulsory, the reduction should take place in the optional courses. The reduction should be done in a way that provides the student with the best grade that has been awarded. The basis for the reduction should be evident from the transcript or certificate.

Chapter 4 Degrees

18 Awarding degrees
The Faculties award degrees with their respective titles in accordance with their delegated responsibility from the Board when the latter approves a new programme of studies.

19 Bachelor’s degree
1. The Faculty awards the Bachelor’s degree on basis of a completed programme of study or a free selection of courses in cases where the student has completed a total of 180 credits. The 180 credits should include:

   - a main profile of at least 80 credits, where the curriculum defines the requirements of the main profile
   - introductory courses of 22.5 credits, ref. Section 13 subsection 4.

2. If the Bachelor’s degree is not based on an established programme of study, the Faculty that awards the degree is to cover the area where the major part of the disciplinary content belongs. If the student has a degree where more than one major parts are is included, the student can decide which of the relevant faculties should award the degree.
20 Master’s degree
1. In order to gain admission to a Master’s programme which is based on a lower degree, the student must
   - have been awarded a Bachelor’s degree or its equivalent
   - have received a passing degree in courses corresponding to 80 credits in the subject area of the relevant Master’s degree, as specified in the curriculum for the relevant Master’s programme
   - have fulfilled the other requirements for admission, as specified in the curriculum for the Master’s programme.

When admission to a Master’s programme is based on experience, the second point is not valid. Instead, at least 2 years of relevant professional experience is demanded.

2. In order to receive a Master’s degree, the student must
   - either satisfy the admission criteria of the Master’s programme and in addition have passes in relevant studies corresponding to 120 credits, where the curriculum allows 30 credits to be replaced by relevant practical experience
   - or have completed a course of studies corresponding to 300 credits, where the requirements of the Bachelor’s degree are included.

3. In the Master’s programme described in Section 20, subsection 2, a Master’s thesis corresponding to at least 30 credits, but no more than 60 credits, should be included.

4. In order to receive a Master’s degree corresponding to less than 90 credits, the specified requirements relevant for such a degree programme must have been met.

21 Candidata/candidatus medicinae
In a programme of studies leading to the degree candidata/candidatus medicinae, introductory courses as defined in Section 13 subsection 4 are included. The degree is based on a coherent course of study corresponding to 360 credits. The Faculty of Medicine will decide the content of the programme of study as well as additional criteria for awarding the degree.

22 Candidata/candidatus psychologiae
In a programme of studies leading to the degree candidata/candidatus psychologiae, introductory courses as defined in Section 13 subsection 4 are included. The degree is based on a study of 60 credits and a subsequent, coherent professional study corresponding to 300 credits. The Faculty of Social Sciences and Technology Management will decide the content of the programme of study as well as additional criteria for awarding the degree.

Chapter 5 Assessment

23 Assessment
1. In all courses or groups of courses included in a programme of study, the possibility for assessment and subsequent grading of the knowledge and skills of the students should be available each academic year. The assessment should be given as a final evaluation, or possibly an evaluation based on different types of on-going assessments described in the curriculum.

2. In order to receive assessment, the student must have registered that same semester, and also meet the academic requirements for assessment given in the course description.

3. A student who has handed in a paper in an assessment cannot prevent the assessment from being done. The student cannot block an assessment if the examination began with an oral test.
24 Examination periods
Final examinations take place at the end of each semester. The Rector decides the time of the examination periods. The dates are given in the curriculum. The Rector may decide to organize the examinations outside the regular examination periods, if practical considerations related to the courses or other things make this necessary.

25 Final examination
The course description states whether the course is to be concluded with a final examination and what requirements the student has to satisfy in order to sit the final examination. A grade is always awarded at the final examination.

26 Instructions at final examination
The Rector can issue general instructions for
- students who are allowed to sit a final examination
- invigilators
- the presence of teaching staff during a written final examination.

These instructions are found in the curriculum.

27 Legitimate leave of absence at final examination
1. If a student is unable to sit a final examination due to illness or other pressing reasons, an application for approved absence has to be submitted to the Division of Student and Academic Affairs. The application, which has to be submitted at the latest one week after the first final examination to which the absence applies, has to contain information about which final examinations the application concerns. Documentation should be included in the application. The period of absence is to be indicated on the medical certificate.

2. A student who is taken ill during a final examination should notify the principal invigilator in the examination hall or the external examiner/internal examiner at oral examinations. The student subsequently has to see a doctor quickly and submit a medical certificate, as stated in the regulations in Section 27 subsection 1.

28 Re-sit examination
1. In a course where the final examination is to be held only once in the academic year, a re-sit examination is to be arranged before the next normal examination. Students with an approved absence may take the re-sit examination. This also applies to students who have not passed the initial examination.

2. Students must register for the re-sit examination within the deadline stated by the Faculty or in the supplementary regulations.

3. The Faculty can in agreement with the Rector decide to organize the re-sit examination during the same period as the normal examination, in the next examination period or at a later time outside the examination period. For certain programmes of study, the time of the re-sit examination will be a standard arrangement that can be stated in the supplementary regulations.

4. During a re-sit examination, the quality of the assessment should correspond to the one given at the normal final examination. Alternative forms of assessment at re-sit examination should be stated in the course description.
**29 Approved absence from other types of assessment than final examination**
The Faculty should, if practically possible, ensure that students with approved absence from other types of assessment than in the final examination can be assessed during the semester and before any possible final examination in the course.

**30 Re-examination**
1. A student who has failed to pass the examination in a course has the right to repeat the examination and receive a new assessment. The course description or the supplementary regulations determine what areas have to be repeated after a student has failed to pass an examination.
2. The student has the right to complete a second period of practical work experience if he/she failed to pass the first period of practical work experience.
3. If the student has passed an examination, he/she has the right to repeat that examination once in one course every academic year in order to improve the grade. In this case, the best grade will count. In cases where the grade is based on a number of partial assessments, all the different components have to be repeated.

**31 New assessment of Master’s thesis**
A student may submit a new or revised Master’s thesis once in cases where the thesis has not been awarded a passing grade. If the thesis has been given a passing grade, there is no opportunity for a new assessment in the same programme of study.

**32 Syllabus at new assessment/re-sit examinations**
In case of new assessment and re-sit examinations, the syllabus of the course at the time of the new assessment or the re-sit examination is to be valid. In cases of changes in the national framework plans, the Ministry may decide upon special arrangements. If there are significant changes in the syllabus, there is to be a possibility to be assessed according to the former syllabus for at least one year, but no more than two years after the introduction of the changes.

**33 Adjusted forms of assessment**
1. In order to give all students approximately the same working conditions when receiving assessment, students with particular requirements that have been sufficiently documented may apply for an adjusted form of assessment. Such an assessment does not imply any reduction in the general degree requirements.
2. The adjusted forms of assessment may be practically oriented in order to allow the use of special aids or extended time. In particular cases, types of assessment that differ from the normal one may also be accepted.
3. If the requirements of the student are permanent, the use of special aids may be allowed throughout his/her studies.
4. An application, including documentation, should be sent to the Division of Student and Academic Affairs before the registration deadline. The application is to be decided by the Rector. Applications for different forms of assessment from the one given in the course description are to be decided by the Rector in consultation with the Faculty.
5. Students with sudden acute requirements should as far as possible be given the same rights with regard to assessment as described above. An application containing sufficient documentation should be sent to the Division of Student and Academic Affairs as soon as possible after the acute situation has arisen.
34 Form of language/language by written assessment
1. Arrangements with regard to the form of language used in examination papers are given in Regulations concerning forms of language in examination papers of 7 July 1987. The regulations are in accordance with the Act of 11 April 1980 no. 5 concerning the use of Forms of Language in the Public Services.

2. Examination papers written in Norwegian should contain a version in the other form of the Norwegian language (bokmål and nynorsk). The exception is examination papers in the subject Norwegian. In case all the students prefer the same form of language, the examination papers may only be written in this form. The students choose their form of language as they register for an examination.

3. If the lectures are given in a non-Scandinavian language, the examination paper should also include a version in the language that has been used in the lectures. Applications requesting the examination paper to be in a language different from Norwegian or that used in teaching are to be decided by the Faculty.

4. If a significant portion of the curriculum of the course is written in a language that is different from the one used in lectures, the Faculty may decide that the examination paper should contain a version in this language as well.

35 Oral examinations behind closed doors
At the request of the student, the Faculty may decide against making an oral examination public in cases where there are pressing reasons, ref. the Act relating to Universities and University Colleges Section 3-9, subsection 3. The Faculty should ensure that the assessment in these cases also satisfies the normal academic level in the programme of study.

36 Academic misconduct or an examination offence/attempted academic misconduct or an examination offence
1. In cases of academic misconduct or an examination offence/attempted academic misconduct or an examination offence, the University Appeals Committee may cancel the assessment in accordance with the Act relating to Universities and University Colleges Section 4-7. The same applies to the recognition of courses, credits or education, as well as exemption from assessment.

2. In accordance with the Act relating to Universities and University Colleges Section 4-8, subsection 3, the University Appeals Committee may expel a student who has behaved contrary to the regulations for up to one year. The student may also lose his/her right to sit for examinations within institutions affected by the ruling for up to one year.

3. More detailed information about reactions to academic misconduct or an examination offence is given in Guidelines for reactions to academic misconduct or examination offences/attempted academic misconduct or examination offences at NTNU of 30 May 2001.

Chapter 6 Determination of grades

37 Examiners
1. The Faculty appoints the examiners, ref. the Act relating to Universities and University Colleges Section 3-9, subsection 2. For inter-faculty courses such as “Experts in Team” that are not administered by one faculty, the rector is to appoint the external examiner(s). If there is an appeal, the Faculty is to appoint the external examiner(s). The examiners are appointed for 3 years at a time.

2. At least two examiners are to be present at oral examinations and assessment of vocational training or other activities of a type that cannot be subsequently checked. At least two examiners, of whom at least one should be external, should be present at the assessment of Master’s theses, ref. the Act relating to Universities and University Colleges Section 3-9, subsection 2.
3. The Faculty determines the guidelines regarding external participation at the assessment, whether
general or a specific programme of study. This could be done by external participation in each separate
assessment or through an external evaluation of the assessment procedures.

38 Deadlines for determination of grades
In accordance with the Act relating to Universities and University Colleges Section 3-9, subsection 4,
the deadline for determination of grades is 3 weeks following the examination, unless special reasons
make it necessary to use more time. When special reasons occur, a new deadline should be announced.
The deadline for assessment of the Master’s thesis is 3 months after the thesis has been handed in.

Chapter 7 Grades

39 Grading scales
Assessment is given on basis of grading, either through a scale ranging from A to F or on the
basis of Passed/Not Passed. Grade A is the highest pass grade, while Grade E is the lowest
pass grade. The grading scale is based on the following descriptions and general qualitative
descriptions:

<table>
<thead>
<tr>
<th>symbol</th>
<th>description</th>
<th>General, qualitative description of valuation criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Excellent</td>
<td>An excellent performance, clearly outstanding. The candidate demonstrates excellent judgement and a high degree of independent thinking.</td>
</tr>
<tr>
<td>B</td>
<td>Very good</td>
<td>A very good performance. The candidate demonstrates sound judgement and a very good degree of independent thinking.</td>
</tr>
<tr>
<td>C</td>
<td>Good</td>
<td>A good performance in most areas. The candidate demonstrates a reasonable degree of judgement and independent thinking in the most important areas.</td>
</tr>
<tr>
<td>D</td>
<td>Satisfactory</td>
<td>A satisfactory performance, but with significant shortcomings. The candidate demonstrates a limited degree of judgement and independent thinking.</td>
</tr>
<tr>
<td>E</td>
<td>Sufficient</td>
<td>A performance that meets the minimum criteria, but no more. The candidate demonstrates a very limited degree of judgement and independent thinking.</td>
</tr>
<tr>
<td>F</td>
<td>Fail</td>
<td>A performance that does not meet the minimum academic criteria. The candidate demonstrates an absence of both judgement and independent thinking.</td>
</tr>
</tbody>
</table>

Passed/Not Passed is used where assessment is not required.

The Faculty is to provide descriptions of the assessment criteria that are specific for each subject.

40 Grade Point Average
The Grade Point Average can be estimated as long as letter grades have been given for at least 75% of
the credits. When estimating the Grade Point Average, all grades in each separate course should be
included. The Grade Point Average is determined as follows:

1. Each letter grade is replaced by its equivalent number, A=5, B=4, C=3, D=2, E=1.
2. The numerical equivalent is multiplied by the number of credits in the course, and the separate
sums of credits and numerical equivalents are added up for all courses that are included.
3. This total is subsequently divided by the total number of credits included in all the courses.
4. The quotient is calculated to one decimal place.
5. The Grade Point Average is the letter degree which represents the equivalent of the full number of the quotient after the normal rounding-up rule has been applied.

**41 Final grade**

1. Whether or not a final grade is to be given is decided by supplementary regulations.
2. The final grade means the overall grade for the entire programme of study at the award of degree. The grade is a weighted average based on the letter grades in the courses included in the degree. In order to get a final grade the student must have a pass mark in courses at NTNU corresponding to at least 120 credits, and at least 75% of these must have been given a letter grade. The method for calculating the final grade is the same as that described for the Grade Point Average in Section 40.

**42 Explanations and appeals**

1. Cases involving the explanation of grades and complaints about them are to be handled in accordance with the Act relating to Universities and University Colleges Section 5-3. Requests for an explanation of grades and complaints should be forwarded to the Faculty. If written guidelines for determining grades have been issued, these are to be made available for students after the grade has been decided, ref. the Act relating to Universities and University Colleges Section 5-3, subsection 3.
2. If there is a new assessment of a grade, at least two new examiners, including at least one external, are to be involved, ref. the Act relating to Universities and University Colleges Section 3-9, subsection 5. The new examiners should not have any information about the initial grade, the explanation for it or the basis of the student’s complaint.
3. When on-going assessment is used, the student cannot lodge a complaint until he/she has received the grade in the relevant course or group of courses. Although the student cannot lodge a complaint following each separate assessment, he/she has the right to an explanation of the grading for each separate assessment.
4. Complaints against procedural errors can be submitted in accordance with the Act relating to Universities and University Colleges Section 5-2. The complaint is to be sent to the Faculty. In accordance with Section 5-2 of the Act relating to Universities and University Colleges, complaints can only be made about on-going assessments which will be included in the certificate or that count as part of the final grade.
5. Complaints about the grading of group work, where a common grade is given, all participating students must agree and sign the complaint. The same applies to complaints about procedural errors in these cases.

**Chapter 8 Certificates and transcripts**

**43 Certificates**

1. Certificates are issued after the completion of a degree or an educational programme. A certificate is normally issued only once for the same degree/education. The certificate is to contain information about the programme of study the degree is based on. The certificate should show the semester and year the degree/educational programme was completed. The final grade (if applicable) is to be given on the certificate. Diploma supplements form a part of the certificate. A transcript of grades showing the courses the student has passed should be attached to the certificate.
2. In order to receive a certificate for a completed degree at NTNU, at least 60 credits have to been taken at NTNU. Of the 60 credits, at least 30 must belong to the main educational profile. With regard to a higher degree, the Master’s thesis must be part of the 60 credits.

44 Transcript
Upon request, students are to receive a transcript confirming their passing grades. The transcript should show the grades given in each course, the year and semester in which the grades were obtained, as well as the title and number of credits for the courses.

Chapter 9 Supplementary regulations and implementation

45 Supplementary regulations
The Faculty has the authority to add supplementary regulations to these regulations. With inter-Faculty programmes of study, the supplementary regulations are to be accepted by all faculties involved. When an inter-Faculty board has been established by the Board of NTNU for a group of programmes of study, the supplementary regulations should be decided by the inter-Faculty board.

46 Implementation
These regulations are to come into force immediately.
Chapter 1 Scope, Purpose and Definitions

1 Scope and Purpose

1. The regulations are valid for all studies at the Norwegian University of Science and Technology (NTNU).

2. The regulations contain rules about the organization of studies, examinations and assessment, requirements for the award of degrees, and regulations concerning the rights and obligations of the University and students at NTNU. The regulations are to ensure that studies and examinations at NTNU are carried out properly.

2 Definitions

Final examination A type of assessment that normally follows at the end of the semester under conditions that can be controlled. The final examination generally is the concluding assessment of the student in a course or a group of courses.

Course The smallest unit in which the student can receive an assessment and course grade. The extent of the course is measured in credits. The course involves activities that form the basis for assessment. The activities may be compulsory.

Subject A collection of courses in one group in a curriculum.

Main profile Courses in a curriculum which are defined as belonging to the same discipline which can supplement each other and build on foundation course level in a programme of study. In case a Master's degree is based on a completed Bachelor's degree, the main profile contains the academic qualifications required for admission to the Master's degree.

final grade The grade given after a course or group of courses. It is based on the assessments that count during that course. The weighting of the grades in assessments during the course is stated in the course description.

Credits Measure of the study workload. The normal workload in one academic year is 60 credits.

Programme of study A group of courses that forms one academic entity that students can apply for admission to, receive the right to study, and leads to a degree.

Field of study A specialization within a programme of study, which is described in the curriculum for that programme of study.

Assessment The evaluations a student receives on the basis of his/her performance in a course, or a group of courses and that lead to a grade.

One-year programme A structured group of courses totalling 60 credits and having separate admission.
These regulations refer to the Act relating to Universities and University Colleges of 1 April 2005, no. 15.

Chapter 2 Admission and individual education plan

3 Admission

The valid admission regulations are the relevant regulations adopted by the Ministry of Education and Research and NTNU’s own admission regulations.

4 Admission to study and progress in studies

1. Admission involves the right to take the courses in the programme of study, a one-year programme or separate courses which the student has gained admission to. Admission provides the opportunity to take the courses specified in the individual education plan or in accordance with the progress in studies approved by the Faculty. Admission to study is valid from the day NTNU receives confirmation of the student’s acceptance of his/her admission.

2. The right to take the programme of study which the student has been admitted to ceases when
   - the student fulfills the criteria allowing him/her to receive a certificate after completing the programme of study
   - the student has completed the one-year programme
   - the student’s progress in studies is insufficient, according to the definition given in Section 4, subsection 3
   - the student himself/herself confirms that he/she has withdrawn from the programme of study before it is completed
   - the student has not paid the semester fee by the stipulated deadline, see Section 6.

3. In programmes of study that are divided into year courses/years, a student cannot take the next year if he/she has an outstanding deficit of more than 22.5 credits from the two previous years. Students who want to take the 4th year cannot have any unfinished courses from the 1st year. Students who want to take the 5th year cannot have any unfinished courses from the 1st and 2nd years, and students who want to take the 6th year cannot have any unfinished courses from the 1st, 2nd, and 3rd years.

   The student loses the right to study a programme of study if he/she has an outstanding deficit of more than 22.5 credits. No student is permitted to use more than 2 academic years to take the same year in a programme of study. The time spent in each year should be adjusted according to any leave that has been granted, and any possible reductions in the study progress (part-time studies) that have been approved in the individual education plan, ref. Sections 5, 7, and 8.

   It is to be evident from the curriculum whether the programme of study is divided into years, ref. Section 14, subsection 1.

   Students that apply for re-admission to the same programme of study will, if applicable, be given recognition of previous studies in the year the student is admitted to. The same is true when there is great degree of similarity between a programme of study a student has applied for admission to and another programme of study a student has or had been admitted to. Exemption to this regulation can be made when more than three years have elapsed since the student was admitted to the other programme of study.

4. The Faculty is to decide whether the right to study should be terminated in accordance with the above regulations. The Faculty may grant exemptions from the regulations in Section 4, subsection 3 in cases of illness, serious family problems, when the main part of the studies has
already been completed, extraordinary conditions related to the subject (taking the next year) or other reasons found to warrant special treatment. Where the Board of NTNU has established an inter-Faculty board for a group of programmes of study, the latter board is authorized to reach decisions in cases related to exemptions.

5. A student who is not covered the regulations in Section 4, subsection 3 has admission withdrawn if he/she has not earned any credits during one academic year in the programme of study or one-year programme that the student is admitted to. This does not apply if the student has registered for and been present at one or more examinations and when it is agreed in the individual education plan that the student is not to earn any credits. The Faculty is to decide in matters of withdrawal of admission.

6. A student who has gained admission to a programme of study and has had normal progress (without adjustment for leave or reduced progress in studies), is not to be affected by changes in the disciplinary objectives, level and structure of the programme while completing his/her work on the programme. The student nevertheless has to accept that there may be changes in the courses and the structure of the programme of study that will not cause a delay in his/her progress.

7. A student who has gained admission to a programme of study, one-year programme or individual courses at NTNU, has the right to follow other courses he/she is qualified to take and receive assessment of his/her performance in these courses. The student also has the right to follow lectures in courses outside the programme of study or one-year programme if there are no restrictions on the admission to the courses. The student maintains these rights also after having completed the programme of study.

5 Individual education plan
The Faculty together with students who have gained admission to study for 60 credits or more are to agree on an individual education plan before the end of the first semester. The individual education plan can be amended in agreement with the Faculty. The individual education plan is a mutual agreement between the student and NTNU concerning the duties and responsibilities of each party for progress in studies as well as the duties and responsibilities of each student towards his/her fellow students. The individual education plan gives the content and progress of the planned studies, cf. Section 6, subsection 2.

6 Registration
1. Students who have been admitted to NTNU have to register and pay the semester fee at NTNU each semester by the deadline set by the Rector. The deadline is given in the curriculum and on NTNU’s Internet pages. Students who do not pay the semester fee by the stipulated deadline will have their admission withdrawn in accordance with the regulations relating to Student Welfare Organizations of 12 February 2001, Section 10. The Faculty is to decide in matters of withdrawal of admission due to non-payment of the semester fee.

2. For students who have agreed to an individual education plan, this registration is to determine and confirm the information in the plan for the current semester concerning
   - which courses the student will attend
   - which courses the student is to be given assessment in
   - other possible activities determined in the programme of study which the student follows
   - other information where adjustments are possible and which is relevant for the student’s progress in his/her studies.
3. Students who are not obliged to agree on an individual education plan or who have not yet entered into an individual education plan also have the duty to register. This registration is to indicate which courses the student will attend and receive assessment in.

4. The registration gives access to the resources offered by NTNU in order to enable the student to complete his/her courses that semester.

7 Leave of absence
1. The Faculty is to handle applications for leave of absence. Such leave from study is primarily given for one academic year. For shorter periods, leave can be given until the end of the semester. A student must have completed more than 30 credits in the courses included in the programme of study in order to apply for leave of absence without stating a reason.

2. The Faculty may accept an application for leave for more than one academic year if there are special circumstances or pressing reasons, such as illness, extensive demands for child-care etc., military service or civilian service.

3. The student must accept that there may be changes in the programme of study during a period when he/she has a leave of absence.

8 Part-time studies
Studies at NTNU may be taken on a part-time basis following agreement with the Faculty. The percentage of the nominal progress in studies is to be included in the individual education plan.

9 Students without the right to study
1. Those who have not been granted admission have the right to receive assessment in a course in accordance with the Act relating to Universities and University Colleges, Section 3-10. The Faculty decides whether the requirements for registration have been fulfilled and may specify further regulations concerning assessment in the absence of normal admission.

2. The Rector may decide upon a special deadline for registration for this type of assessment. The Rector can also decide that those who have not been admitted as students should pay an examination fee in order to cover the extra cost of carrying out such assessments.

10 Teaching – delegation of authority in accordance with the Act relating to Universities and University Colleges Section 3-8
1. The Faculty has the authority to reserve certain lectures just for the students of the University or specified groups of students if the nature of the lectures makes this necessary, cf. the Act relating to Universities and University Colleges Section 3-8, subsection 2.

2. The Faculty has the authority to allow people who are not following normal courses to attend lectures and participate in exercises whenever there is sufficient space.

11 Suspension, exclusion – delegation of authority in accordance with the Act relating to Universities and University Colleges Section 4-8, subsection 1
1. In cases where a student behaves in a way that seriously disturbs the work of fellow students or the general activities of the University, the Faculty has the authority to give a written warning stating that if such behaviour is continued a recommendation concerning suspension will be presented to the Board. In cases that are not specifically related to an individual Faculty, this authority rests with the Rector.
2. The Faculty has the authority to give a written warning to a student that an exclusion recommendation will be presented to the Board unless the suspension decision made by the Board is respected. In cases that are not specifically related to an individual Faculty, this authority rests with the Rector.

3. Complaints about decisions involving a written warning should be sent to the Appeals Committee at NTNU.

Chapter 3 Organization of studies

12 The academic year
1. The academic year consists of 40 weeks and is divided into two semesters. The autumn semester extends over 19 weeks and finishes before the end of the year. The spring semester lasts 21 weeks.

2. The Board of NTNU may approve that a programme of study at NTNU deviates from the ordinary structure described in Section 12, subsection 1 if the duration of the programme is more than 40 weeks and has teaching and/or studies which can be pursued independently of the other studies at NTNU.

13 Programmes of study
1. Programmes of study at NTNU are organized according to the following models, they can
   - lead to a Bachelor’s degree which subsequently forms the basis for a Master’s degree.
   - be an integrated study which leads to a Master’s degree or a professional degree
   - lead to a Master’s degree which is based on a completed Bachelor’s degree or equivalent education.

   The Board establishes and terminates each programme of study at NTNU. When the Board creates a new programme of study, it should simultaneously decide which Faculty is to administer the programme.

2. Each programme of study has a main profile, which gives disciplinary specialization of at least 80 credits. All programmes of study involving 5-year integrated Master’s degrees should also satisfy the requirements of the Bachelor’s degree.

3. Each programme of studies consists of different courses. The courses offered should each be of 7.5 credits or a multiple of that. The courses given in the programme of study are either compulsory or optional. The Faculty establishes new courses and terminates old ones. When the Board at NTNU has created an inter-Faculty board for a group of programmes of study, this authority is vested in this board. The Board at NTNU is to approve the establishment of courses where it is assumed that this will increase the basic disbursement in the State appropriation model.

4. All programmes of study leading to a lower degree as well as integrated programmes of study leading to a higher degree or a professional degree are to contain three introductory courses:
   - Ex. phil. of 7.5 credits that is to be common for all students. Ex. phil. should ideally be a first semester course but this is not compulsory if there are academic grounds to do otherwise.
   - Ex. fac. of 7.5 credits is specific for the relevant Faculty. It should be part of the main profile is and is to be taken in the first year.
   - Perspective course of 7.5 credits that is to represent a different field of study from that included in the student’s programme of study.
13a One-year programmes
The Rector is to establish and terminate each one-year programme at NTNU following a recommendation from the Education Committee. The rector is also to decide which Faculty is to administer each one-year programme.

14 Curriculum and course description
Each programme of study is to be described in a curriculum. The Faculty administering the programme of study is to approve the curriculum. Where an inter-Faculty board has been established by NTNU to cover a group of programmes of study, this board is responsible for compiling the curriculum. The curriculum should contain information about possible admission requirements and ranking regulations for the programme of study. The curriculum should stipulate:

- the learning outcomes and professional objectives of the programme of study
- any required previous knowledge for the programme of study
- which Faculty is to administer the programme of study
- which courses are included in the programme of study
- the scope of the programme of study in terms of credits
- what course combination meets the required main profile
- the structure of the programme of study, whether the programme of study has been divided into years, the fields of study, which are the common courses, which are compulsory and optional courses, and the sequence of the courses
- the possibilities for student exchanges abroad
- other issues which affect the implementation and quality assurance
- transitional arrangements as a result of changes in the curriculum.

All courses are to be presented in a course description. Each Faculty is to provide a description of its own subject areas. Each course description should include:

- learning outcomes
- the qualifications necessary to gain admission to the course
- the content of the course
- teaching methods
- how many credits the course is worth
- the extent of the education
- possible compulsory education
- which activities are included, their extent and which of them are compulsory, for instance courses in methodology, exercises, work experience, field courses, excursions, laboratory work, group exercises, semester papers and other written exercises, artistic performances
- the requirements for receiving assessment
- activities that will be subject to on-going assessment and which of them will count in the course grade
- the organization of a possible final examination (how often, when in the semester, date and similar information)
- what examination support material can be used
- the form of assessment and grading scale for the assessments during the course
the weighting of assessments during the course that are to count in the course grade

15 Recognition of external studies/practical experience
1. The Faculty is to handle applications concerning recognition of external studies or practical experience in accordance with the Act relating to Universities and University Colleges Sections 3-4 and 3-5. A condition is that the external education has been approved as education at university or university college level.

2. The Faculty is to handle applications concerning the approval of an equivalent degree or education in accordance with the Act relating to Universities and University Colleges Section 3-4 subsection 3.

16 Exemption from assessment
1. The Faculty is to grant exemption from the final examination, test or other assessment in cases where the student can document that similar assessment has already been done by NTNU or another institution. The Faculty may also grant exemption on basis of other recognized examinations, tests or other kinds of assessment, or on basis of documented practical experience, in accordance with the Act relating to Universities and University Colleges Section 3-5. When processing such applications for exemption, the Faculty should take both a student’s previous education into account, as well as the assessment in terms of level, scope and content.

2. The student is to send such an application to the Faculty that administers the programme of study in which he/she has the right to study.

17 Reduction of credits
If a student receives assessment in courses where the content wholly or partially overlaps, the total of credits for these courses should be reduced accordingly. The Faculty decides the extent of the reduction in each separate case. If some of the courses to which the student has gained admission to are compulsory, the reduction should take place in the optional courses. The reduction should be done in a way that provides the student with the best grade that has been awarded. The basis for the reduction should be evident from the transcript or certificate.

Chapter 4 Degrees

18 Awarding degrees
The Faculties award degrees with their respective titles in accordance with their delegated responsibility from the Board when the latter approves a new programme of studies.

19 Bachelor’s degree
1. The Faculty awards the Bachelor’s degree on basis of a completed programme of study or a free selection of courses in cases where the student has completed a total of 180 credits. The 180 credits should include:
   - a main profile of at least 80 credits, where the curriculum defines the requirements of the main profile
   - introductory courses of 22.5 credits, ref. Section 13 subsection 4.

2. If the Bachelor’s degree is not based on an established programme of study, the Faculty that awards the degree is to cover the area where the major part of the disciplinary content belongs. If the student has a degree where more than one major parts are is included, the student can decide which of the relevant faculties should award the degree.
**20 Master’s degree**

1. In order to gain admission to a Master’s programme which is based on a lower degree, the student must
   - have been awarded a Bachelor’s degree or its equivalent
   - have received a passing degree in courses corresponding to 80 credits in the subject area of the relevant Master’s degree, as specified in the curriculum for the relevant Master’s programme
   - have fulfilled the other requirements for admission, as specified in the curriculum for the Master’s programme.

When admission to a Master’s programme is based on experience, the second point is not valid. Instead, at least 2 years of relevant professional experience is demanded.

2. In order to receive a Master’s degree, the student must
   - either satisfy the admission criteria of the Master’s programme and in addition have passes in relevant studies corresponding to 120 credits, where the curriculum allows 30 credits to be replaced by relevant practical experience
   - or have completed a course of studies corresponding to 300 credits, where the requirements of the Bachelor’s degree are included.

3. In the Master’s programme described in Section 20, subsection 2, a Master’s thesis corresponding to at least 30 credits, but no more than 60 credits, should be included.

4. In order to receive a Master’s degree corresponding to less than 90 credits, the specified requirements relevant for such a degree programme must have been met.

**21 Candidata/candidatus medicinae**

In a programme of studies leading to the degree candidata/candidatus medicinae, introductory courses as defined in Section 13 subsection 4 are included. The degree is based on a coherent course of study corresponding to 360 credits. The Faculty of Medicine will decide the content of the programme of study as well as additional criteria for awarding the degree.

**22 Candidata/candidatus psychologiae**

In a programme of studies leading to the degree candidata/candidatus psychologiae, introductory courses as defined in Section 13 subsection 4 are included. The degree is based on a study of 60 credits and a subsequent, coherent professional study corresponding to 300 credits. The Faculty of Social Sciences and Technology Management will decide the content of the programme of study as well as additional criteria for awarding the degree.

**Chapter 5 Assessment**

**23 Assessment**

1. In all courses or groups of courses included in a programme of study, the possibility for assessment and subsequent grading of the knowledge and skills of the students should be available each academic year. The assessment should be given as a final evaluation, or possibly an evaluation based on different types of on-going assessments described in the curriculum.

2. In order to receive assessment, the student must have registered that same semester, and also meet the academic requirements for assessment given in the course description.

3. A student who has handed in a paper in an assessment cannot prevent the assessment from being done. The student cannot block an assessment if the examination began with an oral test.
24 Examination periods
Final examinations take place at the end of each semester. The Rector decides the time of the examination periods. The dates are given in the curriculum. The Rector may decide to organize the examinations outside the regular examination periods, if practical considerations related to the courses or other things make this necessary.

25 Final examination
The course description states whether the course is to be concluded with a final examination and what requirements the student has to satisfy in order to sit the final examination. A grade is always awarded at the final examination.

26 Instructions at final examination
The Rector can issue general instructions for
- students who are allowed to sit a final examination
- invigilators
- the presence of teaching staff during a written final examination.

These instructions are found in the curriculum.

27 Legitimate leave of absence at final examination
1. If a student is unable to sit a final examination due to illness or other pressing reasons, an application for approved absence has to be submitted to the Division of Student and Academic Affairs. The application, which has to be submitted at the latest one week after the first final examination to which the absence applies, has to contain information about which final examinations the application concerns. Documentation should be included in the application. The period of absence is to be indicated on the medical certificate.

2. A student who is taken ill during a final examination should notify the principal invigilator in the examination hall or the external examiner/internal examiner at oral examinations. The student subsequently has to see a doctor quickly and submit a medical certificate, as stated in the regulations in Section 27 subsection 1.

28 Re-sit examination
1. In a course where the final examination is to be held only once in the academic year, a re-sit examination is to be arranged before the next normal examination. Students with an approved absence may take the re-sit examination. This also applies to students who have not passed the initial examination.

2. Students must register for the re-sit examination within the deadline stated by the Faculty or in the supplementary regulations.

3. The Faculty can in agreement with the Rector decide to organize the re-sit examination during the same period as the normal examination, in the next examination period or at a later time outside the examination period. For certain programmes of study, the time of the re-sit examination will be a standard arrangement that can be stated in the supplementary regulations.

4. During a re-sit examination, the quality of the assessment should correspond to the one given at the normal final examination. Alternative forms of assessment at re-sit examination should be stated in the course description.
29 Approved absence from other types of assessment than final examination
The Faculty should, if practically possible, ensure that students with approved absence from other types of assessment than in the final examination can be assessed during the semester and before any possible final examination in the course.

30 Re-examination
1. A student who has failed to pass the examination in a course has the right to repeat the examination and receive a new assessment. The course description or the supplementary regulations determine what areas have to be repeated after a student has failed to pass an examination.

2. The student has the right to complete a second period of practical work experience if he/she failed to pass the first period of practical work experience.

3. If the student has passed an examination, he/she has the right to repeat that examination once in one course every academic year in order to improve the grade. In this case, the best grade will count. In cases where the grade is based on a number of partial assessments, all the different components have to be repeated.

31 New assessment of Master’s thesis
A student may submit a new or revised Master’s thesis once in cases where the thesis has not been awarded a passing grade. If the thesis has been given a passing grade, there is no opportunity for a new assessment in the same programme of study.

32 Syllabus at new assessment/re-sit examinations
In case of new assessment and re-sit examinations, the syllabus of the course at the time of the new assessment or the re-sit examination is to be valid. In cases of changes in the national framework plans, the Ministry may decide upon special arrangements. If there are significant changes in the syllabus, there is to be a possibility to be assessed according to the former syllabus for at least one year, but no more than two years after the introduction of the changes.

33 Adjusted forms of assessment
1. In order to give all students approximately the same working conditions when receiving assessment, students with particular requirements that have been sufficiently documented may apply for an adjusted form of assessment. Such an assessment does not imply any reduction in the general degree requirements.

2. The adjusted forms of assessment may be practically oriented in order to allow the use of special aids or extended time. In particular cases, types of assessment that differ from the normal one may also be accepted.

3. If the requirements of the student are permanent, the use of special aids may be allowed throughout his/her studies.

4. An application, including documentation, should be sent to the Division of Student and Academic Affairs before the registration deadline. The application is to be decided by the Rector. Applications for different forms of assessment from the one given in the course description are to be decided by the Rector in consultation with the Faculty.

5. Students with sudden acute requirements should as far as possible be given the same rights with regard to assessment as described above. An application containing sufficient documentation should be sent to the Division of Student and Academic Affairs as soon as possible after the acute situation has arisen.
34 Form of language/language by written assessment
1. Arrangements with regard to the form of language used in examination papers are given in Regulations concerning forms of language in examination papers of 7 July 1987. The regulations are in accordance with the Act of 11 April 1980 no. 5 concerning the use of Forms of Language in the Public Services.

2. Examination papers written in Norwegian should contain a version in the other form of the Norwegian language (bokmål and nynorsk). The exception is examination papers in the subject Norwegian. In case all the students prefer the same form of language, the examination papers may only be written in this form. The students choose their form of language as they register for an examination.

3. If the lectures are given in a non-Scandinavian language, the examination paper should also include a version in the language that has been used in the lectures. Applications requesting the examination paper to be in a language different from Norwegian or that used in teaching are to be decided by the Faculty.

4. If a significant portion of the curriculum of the course is written in a language that is different from the one used in lectures, the Faculty may decide that the examination paper should contain a version in this language as well.

35 Oral examinations behind closed doors
At the request of the student, the Faculty may decide against making an oral examination public in cases where there are pressing reasons, ref. the Act relating to Universities and University Colleges Section 3-9, subsection 3. The Faculty should ensure that the assessment in these cases also satisfies the normal academic level in the programme of study.

36 Academic misconduct or an examination offence/attempted academic misconduct or an examination offence
1. In cases of academic misconduct or an examination offence/attempted academic misconduct or an examination offence, the University Appeals Committee may cancel the assessment in accordance with the Act relating to Universities and University Colleges Section 4-7. The same applies to the recognition of courses, credits or education, as well as exemption from assessment.

2. In accordance with the Act relating to Universities and University Colleges Section 4-8, subsection 3, the University Appeals Committee may expel a student who has behaved contrary to the regulations for up to one year. The student may also lose his/her right to sit for examinations within institutions affected by the ruling for up to one year.

3. More detailed information about reactions to academic misconduct or an examination offence is given in Guidelines for reactions to academic misconduct or examination offences/attempted academic misconduct or examination offences at NTNU of 30 May 2001.

Chapter 6 Determination of grades
37 Examiners
1. The Faculty appoints the examiners, ref. the Act relating to Universities and University Colleges Section 3-9, subsection 2. For inter-faculty courses such as “Experts in Team” that are not administered by one faculty, the rector is to appoint the external examiner(s). If there is an appeal, the Faculty is to appoint the external examiner(s). The examiners are appointed for 3 years at a time.

2. At least two examiners are to be present at oral examinations and assessment of vocational training or other activities of a type that cannot be subsequently checked. At least two examiners, of whom at least one should be external, should be present at the assessment of Master’s theses, ref. the Act relating to Universities and University Colleges Section 3-9, subsection 2.
3. The Faculty determines the guidelines regarding external participation at the assessment, whether general or a specific programme of study. This could be done by external participation in each separate assessment or through an external evaluation of the assessment procedures.

38 Deadlines for determination of grades
In accordance with the Act relating to Universities and University Colleges Section 3-9, subsection 4, the deadline for determination of grades is 3 weeks following the examination, unless special reasons make it necessary to use more time. When special reasons occur, a new deadline should be announced. The deadline for assessment of the Master’s thesis is 3 months after the thesis has been handed in.

Chapter 7 Grades

39 Grading scales
Assessment is given on basis of grading, either through a scale ranging from A to F or on the basis of Passed/Not Passed. Grade A is the highest pass grade, while Grade E is the lowest pass grade. The grading scale is based on the following descriptions and general qualitative descriptions:

<table>
<thead>
<tr>
<th>symbol</th>
<th>description</th>
<th>General, qualitative description of valuation criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Excellent</td>
<td>An excellent performance, clearly outstanding. The candidate demonstrates excellent judgement and a high degree of independent thinking.</td>
</tr>
<tr>
<td>B</td>
<td>Very good</td>
<td>A very good performance. The candidate demonstrates sound judgement and a very good degree of independent thinking.</td>
</tr>
<tr>
<td>C</td>
<td>Good</td>
<td>A good performance in most areas. The candidate demonstrates a reasonable degree of judgement and independent thinking in the most important areas.</td>
</tr>
<tr>
<td>D</td>
<td>Satisfactory</td>
<td>A satisfactory performance, but with significant shortcomings. The candidate demonstrates a limited degree of judgement and independent thinking.</td>
</tr>
<tr>
<td>E</td>
<td>Sufficient</td>
<td>A performance that meets the minimum criteria, but no more. The candidate demonstrates a very limited degree of judgement and independent thinking.</td>
</tr>
<tr>
<td>F</td>
<td>Fail</td>
<td>A performance that does not meet the minimum academic criteria. The candidate demonstrates an absence of both judgement and independent thinking.</td>
</tr>
</tbody>
</table>

Passed/Not Passed is used where assessment is not required.

The Faculty is to provide descriptions of the assessment criteria that are specific for each subject.

40 Grade Point Average
The Grade Point Average can be estimated as long as letter grades have been given for at least 75% of the credits. When estimating the Grade Point Average, all grades in each separate course should be included. The Grade Point Average is determined as follows:

1. Each letter grade is replaced by its equivalent number, A=5, B=4, C=3, D=2, E=1.
2. The numerical equivalent is multiplied by the number of credits in the course, and the separate sums of credits and numerical equivalents are added up for all courses that are included.
3. This total is subsequently divided by the total number of credits included in all the courses.
4. The quotient is calculated to one decimal place.
5. The Grade Point Average is the letter degree which represents the equivalent of the full number of the quotient after the normal rounding-up rule has been applied.

41 Final grade
1. Whether or not a final grade is to be given is decided by supplementary regulations.
2. The final grade means the overall grade for the entire programme of study at the award of degree. The grade is a weighted average based on the letter grades in the courses included in the degree. In order to get a final grade the student must have a pass mark in courses at NTNU corresponding to at least 120 credits, and at least 75% of these must have been given a letter grade. The method for calculating the final grade is the same as that described for the Grade Point Average in Section 40.

42 Explanations and appeals
1. Cases involving the explanation of grades and complaints about them are to be handled in accordance with the Act relating to Universities and University Colleges Section 5-3. Requests for an explanation of grades and complaints should be forwarded to the Faculty. If written guidelines for determining grades have been issued, these are to be made available for students after the grade has been decided, ref. the Act relating to Universities and University Colleges Section 5-3, subsection 3.
2. If there is a new assessment of a grade, at least two new examiners, including at least one external, are to be involved, ref. the Act relating to Universities and University Colleges Section 3-9, subsection 5. The new examiners should not have any information about the initial grade, the explanation for it or the basis of the student’s complaint.
3. When on-going assessment is used, the student cannot lodge a complaint until he/she has received the grade in the relevant course or group of courses. Although the student cannot lodge a complaint following each separate assessment, he/she has the right to an explanation of the grading for each separate assessment.
4. Complaints against procedural errors can be submitted in accordance with the Act relating to Universities and University Colleges Section 5-2. The complaint is to be sent to the Faculty. In accordance with Section 5-2 of the Act relating to Universities and University Colleges, complaints can only be made about on-going assessments which will be included in the certificate or that count as part of the final grade.
5. Complaints about the grading of group work, where a common grade is given, all participating students must agree and sign the complaint. The same applies to complaints about procedural errors in these cases.

Chapter 8 Certificates and transcripts

43 Certificates
1. Certificates are issued after the completion of a degree or an educational programme. A certificate is normally issued only once for the same degree/education. The certificate is to contain information about the programme of study the degree is based on. The certificate should show the semester and year the degree/educational programme was completed. The final grade (if applicable) is to be given on the certificate. Diploma supplements form a part of the certificate. A transcript of grades showing the courses the student has passed should be attached to the certificate.
2. In order to receive a certificate for a completed degree at NTNU, at least 60 credits have to been taken at NTNU. Of the 60 credits, at least 30 must belong to the main educational profile. With regard to a higher degree, the Master’s thesis must be part of the 60 credits.

44 Transcript
Upon request, students are to receive a transcript confirming their passing grades. The transcript should show the grades given in each course, the year and semester in which the grades were obtained, as well as the title and number of credits for the courses.

Chapter 9 Supplementary regulations and implementation

45 Supplementary regulations
The Faculty has the authority to add supplementary regulations to these regulations. With inter-Faculty programmes of study, the supplementary regulations are to be accepted by all faculties involved. When an inter-Faculty board has been established by the Board of NTNU for a group of programmes of study, the supplementary regulations should be decided by the inter-Faculty board.

46 Implementation
These regulations are to come into force immediately.
SUPPLEMENTARY REGULATIONS FOR THE MSC DEGREE IN ENGINEERING (EXTRACT)

Adopted by the Executive Education Committee at NTNU on 23 March 2006 in accordance with the Examination Regulations at NTNU of 7 December 2005 Section 45. Changes were approved by the Executive Education Committee at NTNU on 20 February 2007

These regulations come into force from the academic year 2006/2007

§ 2 Definitions
In the MSc Engineering degree compulsory and elective courses are understood as follows:

Compulsory courses: courses that must be taken in a specific programme of study/specialization

Elective courses: courses that can be selected in a certain programme of study/specialization

§ 5 Approval of the individual education plan
In courses during an academic year where electives are possible, the Faculty is to approve the individual education plan. It is assumed that the courses that are approved in the individual education plan do not collide with the examination plans that have been decided.

It is normally not allowed to supplement compulsory courses or other central or basic courses. Exceptions can be made if changes in the curriculum plan mean that courses should be changed. Courses that were made at NTNU prior to admission to the programme of study can be approved as part of the individual education plan as compulsory/elective courses.

§ 20 Master’s degree

20.3.3
The master’s thesis can be done:

1. Individually
2. In a group with individual assessment
3. In a group with common assessment.

All students can demand to have their master's thesis assessed individually. Forms 2 and 3 can be selected by students if the students form the group and this is approved by their supervisor. In case 2, the contribution from each individual student is to be indicated. When a group solution is adopted, the students have to enter into a prior written agreement to this effect. The parties to the agreement are the students and the supervisor. The terms in such an agreement are stipulated in a standard text.

§ 23 Assessment

23.1.1 Time of the final assessment

The final assessment in a course is normally once a year immediately after the teaching in that course is finished. If the teaching and the final assessment in a course moves the semester into another academic year, the students who have a re-sit examination have to follow the curriculum in force at that time.
23.1.2 Basis of final assessment

Assessment in a course can be based on

- written final examination
- oral final examination
- a piece of work (e.g. project work, laboratory work, field work, home examination and compulsory exercises)
- mid-semester test(s)
- portfolio (two or more of the above forms of assessment where only the final assessment – final grade – is given as a letter grade or as passed/failed)

The final assessment can be based on a portfolio or on one or a combination of more of the above forms of assessment.

23.1.3 Calculation of the final grade when the assessment of grades of parts are given as letter grades

In courses where the assessment of grades of parts is given as letter grades, it is during the final examination grading that it is decided how to calculate the final grade. However the weighting stipulated in the course descriptions for the grades of parts is to be used as a basis.

23.1.4 Assessment of the final grade in courses where the assessment is of a large piece of work that counts for 50% or more

In courses where the final assessment is of a large piece of work that counts for 50% or more, the grade for this work must be a pass in order to get a final grade in the course. The final grade in the course is calculated on the basis for the work and any other assessments in the course.

If the grade for the large piece of work and any other assessments in the course give the final grade of F/fail, the whole of the course must be retaken. If the large piece of work counts for more than 50% there is to be no final examination except for the specialization course. In the specialization course there must be a pass in all part assessments in order to get a passing final grade.

23.1.5 Assessment of the final grade in courses where the assessment is based on part assessment and a final examination

In courses where one or more part assessments form part of the final assessment in that course, a final examination can be held that tests the student in the entire course. There is to be no final examination in a course unless the final examination counts for 50% or more of the final grade. The final examination must be passed in order for the student to get a passing final grade.

If a student does not attend a part assessment, the grade in this part assessment is to be recorded as F/fail.

If the course description states that the part assessment is only to count towards the grade in a positive direction and the student does not attend the part assessment, the percentage weighting of the final examination or the large piece of work is to be:

- final examination or the large piece of work is to count with the percentage indicated in the course description
the percentage of the part assessment(s) is to be added.

A student has the right to take a final examination even if that student has not passed the part assessments that count towards the grade for the course, unless it states in the course description in the curriculum plan that the part assessments are compulsory activities that need to be passed or approved before the student can sit the final examination, see Section 25.0.2 below. A student that does not pass a minor part assessment has no right to re-sit it. A minor part assessment cannot count for more than 30% of the final grade.

23.1.6 Assessment of the final grade in courses where the assessment is entirely based on minor part assessments

In courses where the final assessment is only based on minor part assessments, there is no requirement that the student has to pass all the part assessments to get a passing grade in that course. If a student does not attend a part assessment, the grade in this part assessment is to be recorded as F/fail when calculating the final grade. A student that does not pass a minor part assessment has no right to re-sit it. If the final grade for the course is F/fail, the student must retake the entire course. There is no possibility to have a re-sit examination in such courses.

23.2.1 Assessment based on group work

In courses where the final assessment is completely or partly based on student group work, a work contract has to be established between the students to govern the participation and obligation to attend the group work. The contract should outline the consequences of failure to respect the contract. The teacher with the course responsibility is to take the responsibility for the use of these work contracts

§ 25 Final examination

25.0.1 Requirements for being allowed to sit a final examination

The Faculty is to decide before each final examination what requirements the student has to satisfy in order to sit the final examination. A student is not allowed to sit the final examination if he/she has not completed compulsory exercises or in one way or another has not met the requirements stipulated in the course description regarding the right to sit an examination. If a student does not satisfy the requirements to sit the final examination, there is no possibility to have a re-sit examination.

25.0.2 Time allowed for a written final examination

For courses of 7.5 credits, written final examinations are to have a maximum examination time of 4 hours.

§ 39 Grading scales

Assessment is given on basis of grading, either through a scale ranging from A to F or on the basis of Passed/Not Passed. Grade A is the highest pass grade, while Grade E is the lowest pass grade. The grading scale is based on the following descriptions and general qualitative descriptions:
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
<th>Detailed description of the evaluation criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Excellent</td>
<td>The candidate has excellent knowledge of the discipline and subject matter. The candidate demonstrates an <strong>outstanding</strong> degree of independent thinking and very sound analytical understanding. The candidate also demonstrates excellent skill in the application of this knowledge.</td>
</tr>
<tr>
<td>B</td>
<td>Very good</td>
<td>The candidate has very good knowledge of the discipline and subject matter. The candidate demonstrates a <strong>considerable</strong> degree of independent thinking and sound analytical understanding. The candidate also demonstrates above-average skill in the application of this knowledge.</td>
</tr>
<tr>
<td>C</td>
<td>Good</td>
<td>The candidate is familiar with the most important elements in the subject and the relations between the discipline and its subject matter. <strong>The candidate demonstrates independent thinking.</strong> The candidate also shows analytical skill and understanding. The candidate demonstrates average skill in the application of this knowledge. This average grade can be regarded both as typical for many students taking this subject and also as meeting the requirements of a good performance in the subject.</td>
</tr>
<tr>
<td>D</td>
<td>Satisfactory</td>
<td>The candidate demonstrates some degree of analytical skill and understanding. <strong>The candidate has a degree of independent thinking.</strong> The candidate also has a grasp of the most central elements in the subject and the relations between the discipline and its subject matter, despite having a number of important gaps. The candidate demonstrates some skill in actively applying this knowledge, but this is a below-average performance.</td>
</tr>
<tr>
<td>E</td>
<td>Sufficient</td>
<td>The candidate demonstrates poor analytical skill and understanding. The candidate consistently shows a sporadic grasp of the most central elements in the subject and the relations between the discipline and its subject matter. <strong>The candidate meets the minimum requirements in the subject with regard to knowledge, analytical skill and the ability to apply the subject matter.</strong></td>
</tr>
<tr>
<td>F</td>
<td>Fail</td>
<td>The candidate does not meet the minimum requirements in the subject with regard to knowledge, analytical skill and the ability to apply the subject matter.</td>
</tr>
</tbody>
</table>

Passed/Not Passed is used where assessment is not required.
ASSESSMENT PROCEDURES AND THE USE OF EXAMINERS –
GUIDELINES FOR THE ENGINEERING FACULTIES AT NTNU

The basis for all assessments is stipulated in the Act relating to Universities and University Colleges, Section 3-9:

"The Universities and University Colleges are to ensure that the skills and knowledge of students are tested and assessed in an impartial and professionally satisfactory manner. The assessment is also to reflect the academic level at the stage that has been reached. There is to be an external evaluation of the assessment or the assessment procedure.”

The need for guidelines is given in the Examination Regulations at NTNU, Section 37 paragraph 3:

"The Faculty determines the guidelines regarding external participation at the assessment, whether in general or for a specific programme of study. This could be done by external participation in each separate assessment or through an external evaluation of the assessment procedures.”

The guidelines below represent the minimum demands for the procedures for examiners at NTNU. The individual faculties are free to introduce additional regulations if required.

The purpose of examiners

The objective of using examiners is to give quality assurance. This means that the grades obtained at NTNU are of a satisfactory standard compared with the grades that would have been given in the same or comparable subjects at other Norwegian universities or at reputable international universities. In addition, this is to assure that the assessment procedures that are used in the structure of the grades at NTNU are suitable and adequate in relation to the objectives of the degree, and that the skills and knowledge of students are tested and assessed in an impartial and professionally satisfactory manner.

Guidelines:

I. Categories of examiners and academic requirements

- The examiner with academic responsibility in a course is a lecturer, and he/she is to take the academic leadership in the ordinary examination process. If there is a complaint this person can act as adviser for the Faculty.

- The assessment examiner can be an external or internal examiner. An assessment examiner must have academic education at master’s degree level or higher and is to be a lecturer in the
subject area in question. The internal assessment examiner can be a colleague of the person with the academic responsibility i.e. professor, associate professor, assistant professor, adjunct professor, adjunct associate professor, post. doc., PhD candidate or scientific assistant in the same Department or a Department with related disciplines.

Staff with tenure in lecturing positions at NTNU do not need to be appointed as an examiner. Temporary staff in lecturing positions at NTNU must be appointed as examiners in the usual way.

The assessment examiner in a PhD course must have a PhD/doctoral degree or equivalent that would qualify for a permanent academic post in that subject area.

- **The supervisory examiner** is always an external examiner. An external examiner cannot be a member of the permanent staff at NTNU. The supervisory examiner must have an academic education at master’s degree level or higher and is to be an experienced resource person in that subject area. This person is to have a general interest in the subject and the content of the programme of study and have particular interest in pedagogics, subject didactics and the use of differentiated assessment procedures so that this person is a resource for the programme of study.

The Faculty is to decide whether a supervisory examiner is appointed for a programme of study, a group of subjects/a group of courses or one course.

II. The appointment of examiners and their period of office

- An external examiner cannot be a member of the permanent staff at NTNU.
- An examiner is considered to be external when he/she has not had a permanent position at NTNU for a minimum of one year. The same rule is applicable for those with an emeritus position.
- The Faculty is to ensure that they can call upon at least 4 assessment examiners in each subject area/course, and that at least 2 of these must be external.
- The assessment examiner is appointed for 3-year period, but can be reappointed. The same assessment examiner can be appointed for several courses. The assessment examiner can also be a supervisory examiner.
- The Faculty appoints the supervisory examiner. The Faculty is to decide whether a supervisory examiner is appointed for a programme of study, a group of subjects/a group of courses or one course.
- The supervisory examiner is appointed for 3 years, but can be reappointed.

III. Principles for the use of examiners in assessments or assessment procedures

- A course is to always have an examiner with academic responsibility and a supervisory examiner.
- *The external assessment examiner* can be used to assess an individual piece of work and activities.
- *The external assessment examiner must be* used in addition to the examiner with academic responsibility in the assessment of master’s theses. The external assessment examiner is not to have been involved in the supervision/teaching.
- In the assessment of a piece of work that does not give the examiner the opportunity to assess that piece of work in the light of other work produced at the same time (e.g. master’s theses or large projects), or where the teaching is done in parallel, a grading committee is to be used or
other procedures are to be employed that ensure that the grading system is being used in responsible manner.

- For oral examinations and the assessment of practical work experience or similar that are difficult to retest or for courses with less than 15 students, there is always to be two examiners, the examiner with academic responsibility and the assessment examiner. The Department can decide whether or not the assessment examiner is to be external or internal. The assessment examiner is not to have actively been involved in the teaching of the course in question.

- For assessment of courses (not master’s theses), the Department is to decide which procedure is to be applicable for which course. However this has to be within the guidelines for the use of supervisory examiners and assessment examiners stated below.

For courses the following procedure is to be followed:

1. The supervisory examiner is to assess the academic level and curriculum in the course. He/she is to assess whether the course is given in accordance with the stipulated quality criteria. The supervisory examiner is to issue a statement about the assessment procedure in the course before it is discussed and approved by the management of the department and the programme of study.

   The following elements in the course description must be given to the supervisory examiner for assessment the first time a course is to be approved:
   - The learning outcome of the courses
   - The compulsory activities that are required so that students can be assessed in the course
   - Which activities are included in the assessment
   - Which forms of assessment are used and the weighting of each form of assessment.

   This procedure is only to be repeated if there are substantial changes in how the course is given (learning outcome, content and/or the assessment procedure is changed so much that in examinations a distinction is made between the old and new versions).

2. At intervals of 4-5 years the Department must ensure that all examination answer papers in a final examination are assessed by an external assessment examiner. In this connection the management of the Department is to ensure that the supervisory examiner is involved enough in the assessment of performance that he/she can obtain a realistic picture of the interaction between learning outcome and the academic results from the different courses.

3. When the examiner with academic responsibility has the sole responsibility for examination grading in a course, a small sample (5-10%) of the examination answer papers must be given to an assessment examiner for assessment. The criteria for selecting which examination answer papers should be included in the sample is either at random or selecting papers that represent the highest, lowest and average grades.

IV. Questions to be assessed and guidelines to examiners

The lecturers are to propose the questions that are to be assessed as well as guidelines to examiners. The guidelines to examiners will typically contain the criteria for assessment of examination answer papers, e.g. a proposed solution and possibly how to weight the points and their distribution in deciding the grade. The questions to be assessed and guidelines to examiners must be discussed with an assessment examiner, so that at least two people are
involved in the process. The process is to be documented by those involved by signing the assessed question or otherwise making it clear that the process is completed. The signed document is to be filed by the department.

V. Report and quality assurance

At the end of the semester, a report on grades is to be made for each course. These reports will be used for quality assurance and discussions of the teaching activities at the Department. The Department is to send the statistics for grades via the Faculty or the inter-faculty body where applicable to the grading committee for that subject area at NTNU.

The supervisory examiner is to compile an annual report on his/her work and the quality assessments of the Department with the academic responsibility. The supervisory examiner is to be free to comment on various matters that can influence the teaching, learning outcome, academic level, assessment procedures etc. in the educational activities he/she has supervision of.

The report from the supervisory examiner is to be followed up by the management of the Department with the academic responsibility and is to be assessed according to the quality routines in the Department. The departmental management is to involve the lecturers in the Department in a positive way so that it is possible to discuss the information and evaluate their own work in comparison with the results of others and, if necessary, revise their own teaching. Based on the reports from the supervisory examiners, the departmental management is to assess measures that can lead to improvements in all aspects of a course. If this leads to changes in the assessment procedures, the new assessment procedures in the course have to be approved by a supervisory examiner.

VI. Examination in connection with complaints

When there is to be a new assessment following a complaint, there is to be at least two new assessment examiners where at least one is to be an external assessment examiner. The new examiners are not to have any information about the grade, the explanation of the grade or the student’s grounds for complaint, cf. Examination Regulations Section 42 paragraph 2.

The new examiners are to be sent the examination answer paper, the question paper and the guidelines to examiners that have been prepared for that course. The guidelines to examiners can contain suggested solutions and weighting between the various elements but this is to be updated with regard to the conditions relating to the examination itself. This means that they can be asked to ignore parts of a question where there were errors or where the level of grading has to be adjusted for all the students in that year for various reasons (such as when the question was too easy or too demanding).
The Executive Committee for Engineering Education at NTNU (FUS) is an administrative body reporting to the Executive Committee for Education at NTNU and is to address issues that are described in the mandate for the Executive Committee for Education. The latter can also delegate matters to FUS.

FUS is headed by the Committee chair with the right to attend and participate in meetings of the Executive Committee for Education at NTNU.

The Executive Committee for Engineering Education at NTNU has the following tasks:

1. Present initiatives relating to the MSc engineering education programme to the Executive Committee for Education at NTNU
2. Give advice concerning the structure of the MSc engineering education programme
3. Approve the curricula in the MSc engineering education programme
4. In cooperation with the faculties at NTNU, FUS is to propose the scale of admissions to MSc engineering education programme to the Executive Committee for Education
5. In cooperation with the faculties at NTNU and the various programmes of study, FUS is to ensure that NTNU’s initiatives in educational quality are followed up in the MSc Degree in Engineering
6. Prepare and propose a statement for Rector when NTNU is asked for its point of view in a hearing that relates to the MSc engineering education programme
7. Decide applications for exemption as outlined in the Examination Regulations at NTNU, Section 4, subsection 4 relating to what is standard practice
8. Approve the learning outcomes for the degree and monitor the progress with these learning outcomes in the various programmes of study in the MSc engineering education programme
9. Prepare matters that are to be handled by the Executive Committee for Education. These are to be presented to the Director of the Student and Academic Division
10. Report back to the Executive Committee for Education with the decisions taken in matters delegated to FUS
11. Prepare an annual report on the MSc engineering education programme at NTNU which focuses on measures to enhance quality
12. Actively promote equal opportunity perspectives in the MSc engineering education programme
13. Work to take care of NTNU’s interests concerning representation in relevant national and international bodies and forums.
Mandate for

The Executive Committee for Education at NTNU (UU)

The Executive Committee for Education at NTNU is to bring issues relating to educational policy to the forefront and advise the rector in strategic matters in its area. The Committee's work is to be based on considerations in the Faculties and help to ensure that NTNU has a comprehensive educational strategy with close links to research.

It follows from these objectives that that the Committee is to take the initiative or advise on the further development of:

- interdisciplinary and inter-faculty courses and programmes of study
- pedagogical support and services
- quality of learning
- NTNU's portfolio of programmes of study

Furthermore the Committee is to act as an inter-Faculty board cf. Examination Regulations at NTNU, Section 4, subsection. 4, Section 13, subsection 3, Sections 14 and 45 for the MSc engineering degree and the teacher education programme respectively, for the common courses mentioned in the Examination Regulations at NTNU, Section 13, subsection 4 and the Interdisciplinary Teamwork course.

This means that the following proposals from the Executive Committee for Engineering Education/Executive Committee for Teacher Education the Director of the Student and Academic Division can submit matters to the Executive Committee for Education. The Executive Committee for Education can then:

For the MSc engineering education programme:
1. Advise on strategies concerning the MSc engineering education programme
2. Approve the structure of the MSc engineering education programme
3. Advise on the establishment or closure of programmes of study and specializations
4. Evaluate the relationship between the objectives, tasks and resources available for the MSc engineering education programme
5. Develop common norms and define quality requirements for the programmes of study
6. Make proposals to the Board of NTNU concerning the scale and framework of admissions to the MSc engineering education programmes
7. Monitor the activities of MSc engineering education programme at NTNU. This means among other things discussing the annual report on the MSc engineering education programme at NTNU
8. Influence the budget process so that there is consistency between the academic and strategic priorities and the financial resources available
9. Prepare all matters concerning the MSc engineering education programme that are to be discussed by the Board of NTNU

For the teacher education programmes:
1. Advise on strategies concerning the teacher education programmes
2. Approve the structure of the teacher education programmes
3. Advise on the establishment or closure of programmes of study
4. Evaluate the relationship between the objectives, tasks and resources available for the teacher education programmes
5. Develop common norms and define quality requirements for the programmes of study
6. Make proposals to the Board of NTNU concerning the scale and framework of admissions to the teacher education programmes
7. Monitor the activities of the teacher education programmes at NTNU. This means among other things discussing the annual report on the teacher education programmes at NTNU
8. Influence the budget process so that there is consistency between the academic and strategic priorities and the financial resources available
9. Prepare all matters concerning the teacher education programmes that are to be discussed by the Board of NTNU

**For common courses:**
- Following the given guidelines decide which semester the common courses should be given in the various programmes of study
- Approve the courses that can be included in a common course
- Initiate the development of new courses

**For Interdisciplinary Teamwork:**
- Approve the course descriptions
- Initiate the development of new themes
- Ensure that the development of courses is in line with the Board decision 61/02

**General**

The Executive Committee for Education can delegate powers to authorize the Executive Committee for Engineering Education and the Executive Committee for Teacher Education to make decisions in matters where the Committee finds this appropriate. This is particularly in the areas of responsibility that can be considered in isolation for the MSc engineering education programme or the teacher education programmes.