

NON-TECHNOLOGICAL COURSES IN
THE MSc IN ENGINEERING DEGREE
(SIVILINGENIØRSTUDIET) AT NTNU

REPORT

SUMMARY

As part of the evaluation of the 5 years 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-technological courses as well as on the interdisciplinary course “Experts in Team”. The recommendations from this committee are given in this report. The main aspects that need to be strengthened for the non-technological courses are their relevance, academic level as well as their progression. The main recommendations are:

- The term “non-technological” 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 study programmes, 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 study programmes 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 study programme.

MANDATE

The committee was asked to address and give recommendations regarding the following topics:

- Interplay and integration between non-technological courses and other courses during the engineering education.
- How to include entrepreneurship and innovation in the master of engineering study programmes.
- Globalisation/project management/economics/ Intellectual properties/Legal issues as part of the engineering studies.
- “Experts in Team” as course in the engineering studies.
- Which possibilities for non-technological courses are available at NTNU and which are most relevant for the engineering studies.

COMMITTEE

The committee appointed for giving recommendations within the mandate given in the previous section has consisted of the following members:

Professor Anne Borg, Faculty of Natural Sciences and Technology (chair)

Professor Helge Brattebø, Faculty of Engineering Science and Technology

Associate professor Bojana Gajic, Faculty of Information Technology,
Mathematics and Electrical Engineering

Professor Stig Frode Mjølshnes, Faculty of Information Technology, Mathematics
and Electrical Engineering

Professor Tore Prestvik, Faculty of Engineering Science and Technology

Associate professor Jon Rismoen*, Faculty of Engineering Science and
Technology

Associate professor Tim Torvatn, Faculty of Social Sciences and Technology
Management

Associate professor Kjell Wiik, Faculty of Natural Sciences and Technology

Student Øyvind Aas, Faculty of Engineering Science and Technology

* During the final part of the work associate professor André Liem replaced Jon Rismoen, who at this point had leave of absence from NTNU.

INTRODUCTION

Virksomhetskomiteen 1

The amount and content of non-technological courses were originally described in “Virksomhetskomiteen” (VK1) [1]. In VK1 it was recommended that non-technological courses should comprise one half-year study, equivalent to 30 study points (ECTS credits) or 4 courses of 7.5 study points. The motivation for including such courses to the study programmes was to place engineering into a social context. These courses could either be directed towards the engineering profession or be of more general character. Ex.phil.-related topics for engineering students were to be included in one of these courses. VK1 included the following topics in their recommendations: Ethics, law topics, communication skills, environmental topics, organisation, 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 study programmes or faculties. This interdisciplinary project was the basis for “Experts in Team”, which initially was a course for the engineering studies only, but later has been developed to a common course for all master students at NTNU.

Virksomhetskomiteen 2

The non-technological courses were reviewed through the work carried out by “Virksomhetskomiteen 2” (VK2) [2]. This committee agreed that the engineering studies should include 4 non-technological courses. IKKETEK 1 (Ex.phil.) was recommended placed in the 4th semester rather than the first. IKKETEK 2 was suggested as an obligatory course entitled “Technology management”, placed in the 5th semester and with the following topics:

- Organisation and management/Work and organisational 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, worked out by the study programme boards, fitting the profile of the various study programmes. 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-technological courses.

Courses common to all NTNU students

According to national regulations (Universitetsloven), the Ministry of Research and Education may require that specific courses up to 20 study points must be included as part of any academic degree programme. Today Ex.phil. is required by the Ministry. The Board of NTNU has decided that at least 20 study points of “common courses” shall be included in BSc and integrated MSc programmes at NTNU. This requirement comprises 3 courses, termed “courses 1, 2 and 3”. Course 1 is Ex.phil, Course 2 is Ex.fac. and Course 3 is a so called “Perspective course”. Ex.phil and Ex.fac. are preferably to be part of the first year of study.

The NTNU committee on education 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 shall broaden the perspectives of the studies chosen by the different students and provide insight in own and other disciplines as well as serving as a basis for future interdisciplinary collaboration and communication. For the engineering programmes, FUS, Executive committee for Engineering Education at NTNU, 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 shall represent a different study culture. The lines between study cultures are drawn between different organisational 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, is allowed to offer courses for IKKETEK 3 and IKKETEK 4. One engineering programme, Master of Science in Industrial Economics and Technology Management, does not have the requirements on non-technological courses due to the specific nature of this programme containing a mixture of economics and engineering.

CURRENT STATUS WITH RESPECT TO NON-TECHNOLOGICAL COURSES AND “EXPERTS IN TEAM”

Currently, the status of the non-technological courses in the engineering studies is rather weak, both among the engineering students and academic staff. The committee finds that the term “non-technological” 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 can be read from the answers to some of the questions addressed by selected engineering programmes during the self-evaluation process. The term “non-technological” 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-technological courses.

Ex.phil. (IKKETEK 1)

The engineering students find that 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 very 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.

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.

IKKETEK 3 and IKKETEK 4

The engineering students choose IKKETEK 3 from the 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 the 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 Appendix 1 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 study programmes. The reason for this popularity is at least twofold: (1) Medical topics are of general interest to the individual, and (2) 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-technological 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 boards of the study programmes have had no influence on the choices of the students, except for those programmes, which have selected a specific topic for IKKETEK 3 obligatory to all of their students. Thus, the current regulations lead to weak interplay between IKKETEK3 and IKKETEK 4 and other courses in the study programmes 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 minimum work load invested.

Experts in team

Substantial resources are allocated to the course "Experts in team" (EiT) at NTNU. The committee notes the same challenges for this course as pointed out by the Strategic Committee on EiT, which finalised its report during spring 2007 [3]. In general, the engineering content of this course is too weak for the engineering students, and the learning outcomes vary dramatically depending on which "village" the students have been assigned to. For a more comprehensive description of the status of EiT, the reader is referred to the report from the Strategy Committee [3]. It should be emphasised 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.

DISCUSSION AND RECOMMENDATIONS

General issues

In general, the committee uses the work done by VK1 and VK2 together with input from the different engineering study programmes 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 job market of an engineering education at the Master 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 don’t find it appropriate to discuss non-technological courses as part of the engineering programmes within a framework that is in conflict with the regulations set by NTNU’s board. Therefore, the committee wants to take a pragmatic approach in which the regulations valid for all NTNU students become an integral part of this discussion.

The committee finds that on most points where we are not satisfied with the current situation, is 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.

Status and level of the non-technological courses

In general, the committee is concerned about the reputation of the non-technological 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 committee 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 level in study programs at DMF, HF and SVT, are offered to 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 level, taking into account that the students are mature at this point in their education. In this respect, the committee 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 degree.

Number of Complementary courses

The committee has been discussing the amount of complementary courses in the engineering programmes. The different engineering programmes and specialisations have different requirements in terms of professional and complementary courses. Moreover, the interests of the students vary widely. Based on these considerations the committee suggests that in addition to Ex.phil. and Technology management at least one more complementary course should be obligatory. In addition, depending on the requirements given by the boards of the study programmes and/or FUS, one (or even

two) more complementary course can be chosen. A description of how this can be done is outlined below.

Course contents and organisation

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 committee 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 following 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 between these two courses as they are taught today.

The current flexibility with respect to which semester Ex.phil. is taught in the different study programmes is considered as an asset for the overall structuring of the courses in the programmes. The committee 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 study programmes is more important in this respect. Due to its status through national regulations, the committee recommends that Ex.phil. is referred to with its proper name rather than “Complementary course 1”.

Technology management

The committee 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 organisations employing engineers believe should be taught, the committee recommends that Technology management continues as an obligatory course for all engineering students. The committee suggests that it is referred to as “Complementary course 1”. This course includes topics, which should be part of all engineering study programmes. However, the number of topics covered by the course should be reduced. Thus, the committee recommends, in accordance with suggestions made by Department of industrial economics and technology management, that legal issues are removed as topic in Technology management. The main motivation for this recommendation is that legal issues as a field require introducing 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. The committee recommends that this flexibility is maintained also in the future.

Complementary courses 2 and 3

Regarding Complementary course 2 the committee 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 committee recommends that Complementary course 2 is regarded as “Perspective course” for the engineering programmes.

In Table 1, 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 4th year.

Table 1. Illustration of the options with respect to Complementary course 2 and selection of Complementary course 3 or a technological course.

	Option 1	Option 2
4 th or 5 th year	Complementary course 3	Technological course/Complimentary course 3
3 rd or 4 th year	Complementary course 2	Complementary course 2
2 nd or 3 rd year	Technology management*	Technology management*

* Technology management = Complimentary course 1

There are different views with respect to these alternatives (options) in the committee. 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 organisation, management, legal issues, entrepreneurship and IPR. However, there is a considerable topical spread among the various (16) study programmes, and some have problems finding sufficient room for their technological specialisation courses. Consequently, some committee members argue that it is more important to address this problem than requiring a fixed number of complementary courses. Also, these members think that the boards of the study programmes have the best competence to make the decision 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 board of each study programme to decide if this alternative should be possible for their students.

To ensure sufficient level and progression between the complementary courses, the committee 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 Appendix 2. 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 committee 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) an obligatory course for this programme. The available blocks should be approved by FUS.

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

Experts in Team (EiT)

In the context of the total amount of non-technological 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 obligatory 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.

References

1. Vilje til forbedring”, Virksomhetskomiteen for sivilingeniørstudiet ved NTH, NTH-utredning 1993-8.
2. “Teknologutdanning med perspektiv”, Virksomhetskomiteen (VK2) for sivilingeniørstudiet ved NTNU, NTNU juli 2003
3. “Eksperter i team ved NTNU”, Rapport fra Strategiutvalget for Eksperter i team, NTNU april 2007.

APPENDIX 1. Choices made by the students with respect to non-technological courses during 2006.

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

APPENDIX 2. Suggested “blocks” for Complementary course 2 and Complementary course 3

The blocks suggested are only to outline some themes as examples.

Some examples of possible “blocks” for Complementary course 2 and Complementary course 3

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 commercialisation)

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

Organisational development block:

Complementary course 2:

TIØ5200 Project Organizations

Complementary course 3:

SISxxxx Virtual organisations and change management

SISxxxx Organisations 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.