ROYAL INSTITUTE
OF TECHNOLOGY

Education Assessment Exercise (EAE) 2011

EXTERNAL PANEL OF ASSESSORS REPORT

The Education Assessment Exercise (EAE) 2011

In 2011, KTH Royal Institute of Technology in Stockholm, Sweden, initiated and completed a comprehensive Education Assessment Exercise (EAE). The EAE was a KTH-wide project covering all programmes leading to a professional or a general qualification. The main aim of the EAE was to provide a platform for discussion and self-reflection and thus contribute to quality enhancement. The exercise also provided an opportunity to highlight and remedy possible shortcomings. Furthermore, it served as preparation for external evaluations, including that of the Swedish National Agency for Higher Education scheduled to take place in 2012.

IN THE EAE, an internationally recognised methodology comprising internal self-evaluation and external peer review was used. The self-evaluation phase took place in February–June 2011. For each programme, or group of programmes, a self-evaluation report was produced. The self-evaluation reports covered the programmes' prerequisites, processes and results, and focused on strengths, weaknesses, opportunities and threats.

The self-evaluation phase was followed by a peer review exercise. KTH faculty members involved in the EAE project were asked to propose external panel members whom they believed would make a helpful contribution to quality enhancement. Eight subpanels were formed, as follows:

- Architecture and the Built Environment (ABE)
- Biotechnology (BIO) and Chemical Science and Engineering (CHE)
- Computer Science and Communication (CSC)
- Electrical Engineering (EES)
- Information and Communication Technology (ICT)
- Industrial Engineering and Management (ITM)
- Engineering Sciences (SCI)
- Technology and Health (STH)

With the exception of the BIO/CHE subpanel which covered two schools, each subpanel covered the programmes run by one KTH school. In total, the panel of assessors was made up of 50 subject area experts, experts in the field of evaluation/pedagogy, industry representatives and students, from Sweden, other European countries and the United States. The full list of panel members can be found in Appendix 1.

The panel was furnished with an information pack which contained e.g. the self-evaluation reports, a random sample of students' independent degree project reports, national and local qualification descriptors, a list of quality aspects to be assessed and a report template. On the 23–26 August 2011, a site visit to KTH was organised. The site visit started by way of an introductory session with KTH management and preparatory panel meetings. This was followed by a two-day site visit to the respective KTH schools, where the subpanels interviewed school and programme management teams, teachers and students and, in some cases, alumni and industry representatives. At the end of the site visit, each of the subpanels gave verbal feedback to KTH's central management.

An important part of the panel's task was to provide written feedback to KTH, especially to its central, school and programme management levels. In particular, the panel was asked to highlight strengths and weaknesses and to give recommendations for the future. The panel was also asked to identify examples of good practice as well as shortcomings, with an enhancement focus in mind.

This report contains the written feedback from the eight subpanels. Apart from the consequences of proofreading, texts have not been altered. Statements are wholly based on each subpanel's impressions and interpretations of the information provided and the interviews made. The texts have not been checked for factual accuracy.

Architecture and the Built Environment (ABE) Sub-panel report

Björn Klöve (Chairperson), University of Oulu
Erik Back, Linköping University
Helena Glantz, Urban Design
Lars Hammar, Vattenfall AB
Lars Harrie, Lund University
Jørgen Hauberg, The Royal Danish Academy of Fine Arts
Åsa Lindberg-Sand, Lund university

Feedback to the self-evaluation groups and school management

EXAMPLES OF GOOD PRACTICE AND ASPECTS THAT ARE PARTICULARLY INNOVATIVE

The school covers many disciplines and several programmes are multidisciplinary. The students are needed in society and are easily employed. The students are highly qualified and satisfied. The research is well integrated with high-level research in the engineering disciplines. The bachelor degree project is also well implemented in the school and at KTH. The KTH Learning Lab supports the ABE school where young teachers, and women in particular, attend the courses offered. It is our impression that the master's and bachelor's programmes offer high-quality education with relevant courses. In most cases, the quality of the teaching is also good. The students are followed-up, particularly in the Högskoleingenjör (HI) programme. The school has a good level of contact with its stakeholders.

Several good practices can be highlighted. The mentor scheme in geodesy/geoinformatics seems to be a useful way of introducing students to alumni, future employers and working life. Many methods of continuous learning and CDIO have been implemented, such as project management using a client from the building industry. The intake of foreign students could also provide an added value for Swedish students. Also, problem-based learning is used with learning by doing, which is a good practice.

ASPECTS THAT REQUIRE CORRECTIVE ACTION AND ASPECTS THAT MERIT SUPPORT STRATEGIES

We recommend that the overall school structure should be simpler and improved (appended figure). The structure would benefit from more flexibility on the one hand but on the other hand a stricter requirement on the intake criteria for students. This structure is a flexible Bologna structure as it allows, for example, architects to enter engineering programmes and become architects and HI engineers to move to master's programmes. Also, students without an engineering background should be able to enter master-level programmes (after a personal study programme, if needed). This provides students with a strong and clear identity (Architect and Civilingenjör). These students are needed in the job market. The programmes are also interdisciplinary and provide the students with relevant specialisations for the job market.
The so called S programme in engineering (CSAMH) needs to be developed. The 3rd year must be improved. At present, the students select the study direction in the 2nd year and there are many tracks for the 3rd year; several teachers and programme managers point out that 2 years of specialisation should be sufficient. We recommend a reduction to 2–3 tracks in the 3rd year. It is also important that all master's programmes are represented with bachelor-level courses so that the programmes are properly introduced. This is not the case at present.

More focus needs to be put on learning objectives at programme level in the S programmes. The architecture programme has sufficient focus on learning objectives at bachelor level, but needs to develop it further at master's level. In the HI programme, the learning objectives are implemented at programme level.

Also, managing the programmes can be difficult as individual strong institutions/teachers are responsible for courses. A more direct and strong link to institutes or research groups could be useful. To some extent, more effort is needed to form a common platform that supports the individual master's programmes. Also, more integration could be useful between master's programmes.

It is compulsory to perform course evaluations. Most course coordinators perform evaluations and discuss the results with the students. This process seems to work well. However, evaluation at programme level is weak. The reports from course evaluations are not regularly reported at programme level. Furthermore, a programme evaluation is something more than the sum of the evaluations from each course. Our recommendations are that the course evaluation process is coordinated at ABE school level, methods for programme evaluation are developed and that the different programme coordinators must be more involved in the evaluation process.

More attention and time needs to be put on the supervision of the master's thesis. There is, in some cases, almost a lack of supervision, which leads to a variable level of quality in final degree projects. The teachers and researchers must involve themselves more in the process.

There is simply too little time devoted to it. This process cannot be compared to an ordinary course (credit by credit) when it comes to allocating resources. The thesis is, in principle, a final exam on everything learned over 5 years. Despite a strict thesis format being outlined in the KTH quality manual, this is not seen in many of the final theses. Also, some theses lack any input on individual research. The BSC thesis is a good tool to increase the quality of an MSC thesis, which some of the teachers pointed out.

The implementation of grading of degree projects (A–F) shows a very diverse use of the scale, where some programmes typically use the grades C–D, some A–B and some apply a normal distribution. This variation should be corrected to provide an equal and fair outcome-based assessment for all students in line with the directives from KTH.

More focus needs to be put on the development of expected learning outcomes at programme level for most degrees – with the exception of the Architectural programme. Some of the programme objectives were not designed as learning outcomes at all. In several programmes there were parts of the learning outcomes from the Higher Education Ordinance (HEO) for the degree missing, especially regarding the outcomes in "judgement and approach". More work has to be done to align the learning outcomes for each course to the ones specified for the programme and for the degree in the HEO.

The level of student contact with alumni and industry could be strengthened further, especially in the S programmes, where the students ask for greater and earlier contact with industry. In the ARKIT programme, a large number of students chose to take a year off to work as interns, but there is no strategy from the school about how these internships relate to the overall learning objectives.

Feedback regarding the Master of Architecture (ARKIT) programme

OVERALL STRENGTHS AND WEAKNESSES

The programme produces graduates of a high quality, giving the programme a good position in the European landscape of architectural education.

The potential of the programme is, first and foremost, expressed by the students' ability to seize actual, relevant questions and approach them in an analytical way. This could form the basis of a new profile, which could include a sociological approach.

EAE self-evaluation process

An ambitious and honest self-evaluation report, carried out in a convincing way, demonstrating the existence of a well-functioning quality culture involving staff members.

However, the interviewed students did not feel ownership of the self-evaluation.

Prerequisites

Good connections to the profession through collaborations with professionals and practitioners within the trade. Good combinations of skills and competences among the staff.

However, this connection to practise is not really reflected in the students' work, in forms of technical skills or practice-based projects.

There is a large group of visiting lecturers, but a relatively small group of teachers with regular forms of academic employment, which leads to a risk of fragmentation within the programme and lack of inner coherence in the teachers' group. Even within the academic staff: *"only a handful are employed as full-time academics"*.

The distribution does not support a research culture which integrates research into how the studio works.

Good internationalisation by students studying abroad for a period of time and good professional exposure by students taking a year off. However, this also creates problems which are analysed below.

Educational processes

A good educational structure, combining project-based and theoretical teaching, organising students into studios. Good intentions about teachers' teams, junior-senior pairs, group collaborations and interdisciplinary cooperation.

An open-minded attitude towards teaching methods and new thinking.

However, the units are small with little critical mass and there is a lack of coherence between the units. The model would benefit from a well-defined coordination and leadership across the studios.

The integration of courses in the project studies is a clear benefit to the programme. Also, the efforts made by management to introduce a sharper pedagogic vision, increase pedagogical awareness and clarify the responsibilities and decision-making processes, are initiatives, together with the rest of the initiatives from the 5 points, which are both productive and useful.

Learning outcomes
Well-established programme objectives in the 1–3-year bachelor programme. The content of the bachelor programme is relevant, challenging and combines the different aspects of education in a positive way and with a good level of progression.

However, the self-evaluation does not actually assess the learning outcomes, but instead looks at the programme's goals. There is no description of the 4–5-year master's education.

Student retention
The dropout rate of students at master's level and the students' retention and median completion rate are problematic.

Especially in year 4, many students take leave of absence for work or internships. Also, in year 4 many students study abroad and there is a large intake of exchange students. For these reasons, year 4 is different to the other years of the programme, and has a weaker coherence than at bachelor level.

Although internationalisation and time for professional practice are of great importance, management must ensure that the low completion rate and leave from programme are not symptoms of disrespect for the programme's degrees or an unfocused master's programme.

Graduate employability
A high rate of employability among the graduates, indicating that the graduates have skills and competences on a sufficient level and that they live up to professional expectations.

Student satisfaction
The students' satisfaction with the programme and the level of teaching is very high. Students are strongly committed to their education and future profession.

However, the students are not satisfied with the implementation of the new grading system.

RECOMMENDATIONS FOR THE FUTURE
Responsibility and leadership of programmes and courses rests too highly on visiting lecturers, and should be dedicated to the academic staff. Research and researchers should be integrated in the teaching, from studio projects to theoretical works.

The distribution of teachers should be changed over time. The number of temporary staff should be reduced in favour of academic, research-based and full-time employed teachers.

The programme should keep a reasonable proportion of practice-based teachers.

The programme should incorporate research, like other KTH programmes.

Combination and internal coordination of the studios should be implemented in order to strengthen the study model.

Engaging guidelines for the master's programme should be formulated in order to attract students and support their fulfilment of the study.

Management should take action on the low completion rate.

Leave for practice and international exchange should be controlled and time limited, and students should be actively advised on these matters.

Good facilities, tools and technical equipment should be ensured: workshops, digital environments, library and archive.

Feedback regarding the Master of Science in Engineering in Civil Engineering and Urban Management (CSAMH) programme

OVERALL STRENGTHS AND WEAKNESSES
The programme has gone through several changes over the past couple of decades. This has been an exhausting process for staff/teachers and perhaps also, in some sense, for students. This situation constitutes a challenge for the future. In spite of this the programme produces high-quality students with a good employability level.

EAE self-evaluation process
A report that, in general, only states statistics etc., and really does not touch on issues of strengths and weaknesses or development, such as the CDIO process etc., in any depth. Consequently, there is a lack of reasoning in the report. In general, the report mostly covers the first 3 years (BSC).

Prerequisites
Noting the very broad-ranging disciplines and, consequently, large number of courses the programme covers, the existing staff seems to have a good level of competence and skill. In some disciplines, the programme also seems to have a good to very good contact with external stakeholders. The number of choices among courses from the 3rd grade and up constitutes a real challenge for the staff to handle under given economic and other prerequisites. Individual course economics and, correspondingly, long-term quality must suffer because of this situation. Nowadays, the programme seems to have a good to excellent application rates and, consequently, well-motivated students with reasonably good retention rates. The present employability level of the students is also excellent.

Educational processes
Given the circumstances with the large number of courses given, the content seems to be of satisfactory quality, although sometimes it appears a bit old-fashioned.

Degree projects in the 3rd grade are implemented with good results, and this will, in the long run, increase the quality of the master's theses too. Today, these have a varying level. There is also a lack of a clear vision regarding the programme's short- and long-term development. This is probably due to the economically difficult situation which has put a lot of pressure on the staff.

Learning outcomes
At course level, there is a functioning process on following up learning outcomes. At programme level, this is completely missing.

Student retention
The student retention rate is quite good.

Graduate employability
The students have a very good employability. This situation, which was quite different 15–20 years ago, is judged by the panel to continue for a foreseeable time period in the future.

Student satisfaction
In general, there is a high level of satisfaction and also a strong belief that their abilities, competencies and skills will be competitive. On this programme there are, of course, as on most other programmes, some dissatisfaction with individual courses, mostly maths. There is a wish to move some theoretical courses to later years in favour of some more applied courses in the first few years.

RECOMMENDATIONS FOR THE FUTURE
It is important that the new structure with the 5 master's programmes is settled and that the programme management and teachers get sufficient time to develop these new master's programmes. Among others, it is important to emphasise the need to have an early strategic discussion on the learning outcomes in order to keep/develop the necessary quality in the course programme. This is also necessary in order to give interested students a good picture of what competences and skills (and the progression in the course programme) they will develop if joining the programme. The new master's programmes, which will be broader than the old ones, should contain some elective courses (which should be possible to take from other master's programmes).

The number of specialisations during the 3rd year of CSAMH must be reduced to 2–3 specialisations. Several of the teachers and programme managers also pointed out that 2 years of specialisation is enough if the students have a sufficient background. To provide this background we would suggest two major clear lines in the first 3 years of the CSAMH programme, one with a strong technical/natural science direction and one with a more societal planning/economical direction (although still including the relevant technical competence and skills required). In the long run, the panel also believes that this would give the ABE school a good competitive position in relation to both national and international students. This would also give the opportunity to balance staff members, course numbers and content together with programme economy in a reasonable way.

The number of students must be increased at master's level. This should be done by: (1) increasing the number of new students on the CSAMH programme and (2) providing better opportunities for students with a bachelor degree to enter the master's programmes (e.g. a good opportunity to complement with missing courses etc.).

Another issue that is important to raise is the quality of the master's theses. Both the teachers and researchers must involve themselves more in the theses process as, at present, there is not enough time dedicated to this. This process cannot be compared to an ordinary course (credit by credit) when it comes to allocating resources. The thesis is, in principle, a final exam on everything learned over 5 years. The BSc thesis is also a good tool to increase the quality of MSC theses, which is pointed out by several teachers.

The need to develop teaching skills and also the knowledge of English are issues frequently raised by the students. Consequently, KTH's efforts in the Learning Lab are very important, and the hope is that not only new teachers, especially the all too few female ones, but also the older teaching staff see the opportunities. KTH has to consider introducing a "teacher career path" directed to those who realise that they prefer teaching to research.

There is also a need to develop and clarify the different levels of decision-making within KTH:

KTH (central) – school – programme management – programme council – individual professors. The programme level, including programme management and programme council (non-existing), seems to be underutilised or weak. This is important, as there is, among other things, as earlier mentioned, a lack in following up learning outcomes at this level. There also seems to be a somewhat unclear situation of the responsibility of the first 3 years of the programme.

Since the programme management is weak in comparison to the departmental management, it is apparent that there is a difficulty in performing the necessary programme-level changes in the first 3 years – the economical interest of the departments (and the common KTH rules for CI education) seems to have a higher priority.

Feedback regarding the Master of Science in Environmental Engineering and Sustainable Infrastructure (TEESM) and the Master of Science in Water System Technology (TWSTM) programmes

OVERALL STRENGTHS AND WEAKNESSES

The programmes produce MSC graduates with a focus on environmental management (TEESM) and MSC/Civilingenjörer with a focus on water engineering (TWSTM). Both programmes are of a high quality and have a separate and unique focus relevant to the market. The TEESM programme, however, lacks an engineering focus and therefore an identity as an engineering programme. The future new school should have the water-engineering platform as a base with innovative input from wider management aspects. This should give the school a profile with relevant engineering problem-solving tools and a natural science background as well as some socio-economic and planning aspects relevant to implement sustainable solutions into society.

EAE self-evaluation process

The self-evaluation report shows a well-functioning quality culture involving staff members, PhD students and students. However, the communication between students and activities at different institutes involved in the programme seems somewhat distant and not transparent. The students need to be better informed about activities and career opportunities at institute level.

Prerequisites

The competence of the staff is good. The teaching in the TEESM programme seems to be strongly linked to research. This seems to be a bit weaker for some courses in the more traditional TWSTM programme. PhD students could perhaps be better used as a link between programmes, institutes and programme students. This could ensure more feedback for continuous course development.

The present structure, with intake from S programme and almost all other sources for TEESM, seems somewhat difficult. To take in students with poor skills in mathematics and physics/chemistry will be difficult in the future. It seems as if most students in the TEESM programme have the mathematical and physics skills needed at entry despite the fact that this was not required. In order to achieve a more homogenous student group at entry, particular entry requirements for non-S programme students is suggested. This will also avoid unnecessary repetition of issues already taught to S students. To some extent, it seems as if student pre-qualifications are not always checked before giving assignments or programmes (e.g. Matlab) to work on.

Educational processes

The education structure and courses are good. Also, different learning methods are used. The MSC programme cannot influence the bachelor courses. This can, however, be solved with the suggested more uniform structure, focusing more on engineering.

The final degree project is currently being delayed due to lack of supervision and contact with industry and ABE research groups/institutions. This needs more resources and a greater focus.

Learning outcomes

A good diversity of continuous learning methods is used in individual courses. At programme level, the learning outcomes are not as well defined as on course level. The CDIO process needs more focus at programme level. This is especially important when planning for a new programme.

Student retention

This does not seem to be a problem. The retention is somewhat reduced in the final stages, especially for international students, due to difficulties in finding and starting the degree project.

Graduate employability

As most students return to their home country, the rate of employability has not been checked in a systematic way. It seems to be good based on student and teacher interviews. The students see KTH as a guarantee that will ensure they get high-quality jobs in their home countries.

Student satisfaction

Students' satisfaction is very good. To some extent, they would prefer a more open contact with institutions. The possibility of gaining a PhD seems to be important to international students.

To some extent, the students do not see a clear connection and continuation between bachelor courses and master's-level courses. Some of the bachelor courses seem to be somewhat vaguely linked to their future profession.

However, the evaluators see that a wide approach is needed in the S programme to give the identity of a "civil engineering" programme. The bachelor programme content of the S programme is a challenge for the entire engineering programmes and needs attention. One option could be to introduce more wider or holistic courses with CDIO generic learning outcomes and to increase optional courses.

RECOMMENDATIONS FOR THE FUTURE

We recommend that the future new school should have the water-engineering platform as a base with innovative input from wider management aspects. The school should have a strong base in natural sciences, methodological and engineering methods and problem-solving. This will give the student a strong identity in the end.

The past internationalisation and intake of foreign students is important to provide a good and diverse learning environment. As the engineering programmes have undergone so many changes in the past, it is recommended that changes are well motivated to staff members and perhaps more gradually introduced based on a long-term vision. The opportunity-driven strategy is exhausting for teachers.

We recommend that links from the programmes to institutes are improved. This could be done with active PhD contact, active use of mailing lists (e.g. job announcements), training periods and internships. More attention should be given to management and learning outcomes at programme level. At the same time, it is important to maintain and encourage activities at the grass-roots level and not develop a top-down strategy. The CDIO process must be analysed for the entire programme. This would give better generic skills to students (writing, managerial skills etc.).

Feedback regarding the Bachelor of Science in Real Estate and Finance (TFOFK), the Bachelor of Science in Property Development and Agency (TFAFK), the Master of Science in Real Estate Development and Financial Services (TFAFM) and the Master of Science in Economics of Innovation and Growth (TEINM) programmes

OVERALL STRENGTHS AND WEAKNESSES

The programmes produce graduates with a high employability who are generally satisfied with their education.

The greatest advantage of these programmes is their uniqueness in comparison with other programmes, which even allow bachelor students to compete with students from other "5-year programmes".

EAE self-evaluation process

The self-evaluation report is well written with relevant and analytical content. The EAE process was met with great enthusiasm from the programme management, teachers and students.

Prerequisites

Most of the teaching staff either work or do research in the same field as they teach; therefore, the programmes have a close connection to both the profession and to research.

However, this commitment to other tasks besides teaching comes with the risk of teachers not having the time to attend, e.g. the "Learning Lab".

The recruitment situation for the TEINM has changed dramatically due to the introduction of the admission fee, which has led to a huge drop in the number of international students. This situation should be analysed in order to understand how this is going to affect the future of the programme.

Educational processes

The level of education has received a generally good grade from the students. The teaching methods used, such as "student-led lectures" and interactive seminars, are appreciated. However, the maths course included in the TFOFK programme needs to be revised in order to achieve a better fit in the programme.

In the TFAFM programme, teamwork tends to be used by teachers as a tool to reduce their own workload, rather than to teach the students how to work in groups. Also, the course sequence is not perfect: some courses are too hard initially, while others are perceived as repetition from previous courses. Stronger feedback on reports/papers has also been asked for.

The exchange of information among teachers contributing to the same track is good, but communication between teachers contributing to different tracks is poor.

Students from all programmes, except TEINM, tend to skip visiting lectures because they feel that these are not closely related to the exam.

Learning outcomes

The programme produces students with relevant knowledge and who are highly sought after in the job market.

The improvements of the bachelor degree project work should greatly improve the quality of the thesis; however, to ensure the quality of the students graduating from TEINM, the increased rate of plagiarism needs to be combated.

Student retention

The master's students have a relatively high retention rate and seem to be motivated to complete their studies. Unfortunately, the bachelor students do not share the same statistics. Due to a combination of high employability and low interest for completing the maths course, the students lack incentives to complete their degree.

Graduate employability

The employability rate is high for all programmes. The TFOFK students are even employed before their graduation, indicating a hungry job market. However, this is also a problem, since employed students lack incentives to complete their studies.

There is not enough data to draw any conclusions about the employability rate for the TEINM programme. The follow-up work on TEINM graduates should be improved, and the fact that the number of foreign students has decreased should make this easier.

Student satisfaction

The general opinions of the students are that the programmes are satisfactory. However, the bachelor students have problems getting into the master's programme due to unfinished courses and a strict limit on the number of students with bachelor exams that are allowed to enter the master's programme. They think it is unfair that they have to complete every course to be able to begin the master's programme and claim that this causes stress, which leads to a student work-health problem. Several of the bachelor students have gone abroad to take a master's degree, which might be caused by the fact that it is difficult to continue their studies at KTH. A bad connection with the professional market has led to an uncertainty in the TEINM programme as to what their studies will lead to.

RECOMMENDATIONS FOR THE FUTURE

The creation of a new programme, by merging the two very similar programmes TFOFK and TFAFK, should be considered. This new programme would then have tracks matching the two programmes it replaces.

TEINM's alumni network should be expanded and utilised in such a way so that there is less uncertainty regarding what the qualification will lead to. TEINM should also hire relevant guest lecturers for the same purpose. Also, students should be offered internships in appropriate companies.

A better forum for information exchange between the programme management, teachers and students should to be developed.

The number of guest lectures for the bachelor programmes should probably be lowered, or at least chosen more carefully, so that they are closer to the focus of the actual examination.

To increase the retention rate for the bachelor students, it is important that they realise the importance of a completed degree. The school management should have direct control over the maths course in order to be able to shape it to suit the programme better. Also, the possibility of using students' part-time jobs to strengthen the link between teaching and the job market should be investigated.

The tracks should be broadened and include some elective courses. For example, it is apparent from the self-evaluation report and the interviews that students focusing on economy need more courses in law, and vice versa. This could also be realised by more joint courses in the 3rd year of the CSAMH programme.

Feedback regarding the Master of Science in Geodesy and Geoinformatics (TGEGM) and the Master of Science in Transport Systems (TTSYM) programmes

In our evaluation of the programmes (weaknesses and strengths) we treat TGEGM and TTSYM as separate programmes. In 2012 the programmes will be merged into the new programme Master of Science in Transport and Geoinformation Technology (TGT); the recommendations for the future are written for this programme.

OVERALL STRENGTHS AND WEAKNESSES

The programmes produce graduates of a high quality that are very attractive to the labour market. The main challenges are to find a good profile for TGT and to attract more students.

EAE SELF-EVALUATION PROCESS

TGEGM and TTSYM have made a joint ambitious self-evaluation report. The self-evaluation process has been timely, since it has coincided with the process of merging the programmes. The self-evaluation process has enhanced the knowledge of "the other programme" among the programme's management and the teachers.

Prerequisites

The programmes have good connections to the profession and to research.

There are too few Swedish students applying for the programmes. Both programmes have had several foreign students who have kept the total number of students at an acceptable level. The number of foreign students has decreased with the introduction of new fees, but it is noteworthy that TGEGM has four paying students in 2011. However, there is a substantial risk that the number of foreign students will decrease, since few are looking for a programme in "transport systems AND geoinformatics". Several of the students pointed out that they searched for a specialised programme when they applied to KTH.

Educational processes

The education process has a good mixture of traditional teaching and problem-oriented teaching. The students feel that they have received sufficient preparation for written and oral presentations as well as teamwork training. However, the teamwork training is always with students who are in the same programme.

The development of the courses has often been a responsibility of single teachers. However, in the near future they plan to coordinate this activity through a programme council for TGT.

Learning outcomes

TGEGM has established programme objectives while TTSYM has a traditional programme description. There is an ongoing process to formulate programme objectives for the TGT programme.

There are learning objectives for each course. The students are generally aware of these objectives and feel that they are assessed according to them.

Student retention

The student retention has been high to very high for TTSYM but lower for TGEGM. Two reasons for the low numbers of students that actually graduate are: there is no time limit for the degree report and no limit to the number of times an examination might be taken.

Graduate employability

For both programmes, all of the Swedish students have found employment immediately after graduating, but it seems to be somewhat harder for the foreign students (probably due to lack of ability in the Swedish language which is often required in these fields). There are generally too few Swedish-speaking students in the programmes to satisfy the demand from the labour market.

TGEGM has a mentor programme with alumni and students. The students have greatly appreciated this initiative.

Student satisfaction

Surveys have shown that the students are generally satisfied with the programmes. The TTSYM students are especially satisfied with the "subject matter", while the TGEGM students especially appreciate the laboratories and the fieldwork.

RECOMMENDATIONS FOR THE FUTURE

The current main task is to establish the new joint TGT programme. TTSYM and TGEGM have both been highly specialised programmes that have attracted too few students. The challenge is now to find the overlapping area of the two old programmes and to build a new identity around this core.

Since the merging process has been mainly triggered by economical reasons (and KTH management decisions), some members of staff are rather reluctant to adopt the process. This is only natural, since the merging process will inevitably lead to fewer specialised courses. However, we would stress the importance that the whole staff work to create a new joint programme and do not strive to keep their old programmes under a new TGT umbrella. Important factors here are: common office locations, the joint programme council and joint research projects.

For the new TGT programme, it is important to identify common subjects that have not been dealt with earlier in the CSAMH programme, e.g. statistics, numerical methods, computer science, spatial/system analyses and visualisation. Apart from these common methodological courses, it would be possible to establish some courses in transport systems and geodesy/geomatics that are of interest to all students in TGT as well as a joint project course.

The main challenge is to attract new types of students to the TGT programme. Both TTSYM and TGEGM have mainly attracted (foreign and Swedish) students with the ambition of specialising in respective fields. The new TGT programme must strive to attract (mainly Swedish) students who have a more general interest in society and technology. Both TGT and TTSYM are programmes that utilise advanced technical theories and methods to solve society's needs (mainly working in consultancy companies or authorities); this combined identity is important in the marketing of the new TGT programme.

A key issue for the TGT master's is the structure of the first 3 years of the CSAMH programme. This is discussed in the CSAMH part.

Feedback regarding the Master of Science in Sustainable Urban Planning and Design (THSSM) programme

OVERALL STRENGTHS AND WEAKNESSES

The programme produces graduates of a high quality.

The potential of the master's programme is, first and foremost, expressed by the students' ability to seize actual, relevant questions and approach them in an analytic way, with parallels to the way research is carried out as written reports and analyses.

The students' projects reflect a sociologic approach more than the practice-based and technologic approach.

The mixed background of the students provides a good learning environment.

EAE self-evaluation process

In general, a well-functioning quality culture involving staff members at the programme. However, the self-evaluation does not carefully assess strengths and weaknesses.

Prerequisites

Good combination of skills and competences among the staff. Architects, civil engineers, teachers from social and natural sciences, theoretical and practical aspects are reflected in the composition of the staff.

Good intentions regarding interdisciplinary research and teaching. However, this is yet to be proved, and only a small core group of teachers regard the programme as their prior commitment. Also, a general problem is the high turnover of teachers. Good balance between males and females.

Good combination of international and Swedish students, although the amount of exchange students has declined. This emphasises the need for a highly committed programme attracting Swedish students.

Educational processes

Well-suited structure of education combining project-based and theoretical teaching organised in studios. Rather traditional attitude towards teaching methods.

However, the profile of the three tracks in the programme is not convincing and the combination of this and having only a few places in the programme is disadvantageous.

Interaction and cooperation between the tracks and among teachers should be improved.

The great opportunities of a new interdisciplinary programme and new combination of skills and competences are not reflected in new thinking and intense collaboration among staff members. The tracks are small with little critical mass and there is a lack of coherence between the tracks. The programme management and the academic staff should establish a common identity that crosses both groups and tracks. This should be ensured through leadership.

Learning outcomes

Programme objectives are relevant, challenging and combine the different aspects of education: practice, theory, technology and social aspects.

Strong research-based analytical approach, with a majority of the teachers as active researchers.

However, the practical and design approach to planning and architecture seems to be weak and requires improvement.

The self-evaluation does not actually assess the learning outcomes, but instead looks at the programme's goals.

Student satisfaction

The students are very satisfied with the programme and with most of the teachers, but they are not always challenged by the academic level of the courses.

The students expressed uncertainty about their future professional identity and the professional roles for the three tracks. A benchmarking process, as suggested in the self-evaluation, should be carried out to study different professional roles and needs in the labour market.

RECOMMENDATIONS FOR THE FUTURE

Strengthen the students' ability to transmit knowledge and competences into plans, to design, to produce new concepts and to use architectural quality in their analyses. Involve more practice-based teachers and visiting lecturers to support an integration of the analytical approach and a form-giving, practical process.

Give academic teachers the opportunity to concentrate on the programme.

Insist on collaboration and a high commitment from each person. Building up a new programme must be done in a spirit of entrepreneurship, enthusiasm, constant leadership and close contact with the rather small group of students.

Give access for a Bachelor of Architecture to fulfil a Master of Architecture through THSSM.

Adjust the tracks and programme accordingly, ensuring the education of professional planners.

Either allow the master's programme to grow or combine the three tracks into one. It seems as if the division of the master's into three tracks is partly based on history and on a wish to have different prerequisites in the same master's programme (one for each track). Since the latter will not be allowed, the programme management and the teachers really should consider if the division into three tracks is motivated, or if it is possible to have one track with more elective courses.

Feedback regarding the Master of Science in Architectural Engineering (THUSM) and the Master of Science in Infrastructure Engineering (TISEM) programmes

OVERALL STRENGTHS AND WEAKNESSES

The school produces graduates of a high quality with a competence that is much sought after by industry.

It has well-qualified teachers with a strong connection to research that, combined with a wide range of guest teachers from industry, ensures a high-class education.

The students are motivated and well qualified for their studies.

There is a good gender balance among the students and a fairly high amount of exchange students.

However, the programmes seem somewhat conservative to the subject and uncritical towards industry. At present, the programmes appear to be mostly the sum of the different courses.

The focus on a sustainable environment and cooperation between different fields within the building industry could be stressed further.

The opportunity for the students to get more knowledge within the field of practice could be developed further, by introducing a trainee system ("praktik") that is integrated in the programme.

There is a lack of female role models within the permanent teaching staff.

EAE self-evaluation process

The self-evaluation report is well structured and representatives from the programme management, teachers and students have all contributed to the report in different ways. However, it is very hard to understand from the report how the programmes work to ensure that the students meet the stated learning outcomes. There is also a lack of information about how the programmes work with sustainability issues and internationalisation.

Prerequisites

The school has good connections to the profession. There is a good combination of skills and competences among the staff. The lack of female role models is met by inviting female professional guest teachers from the profession.

However, it is important that these guest teachers are well integrated into the overall educational programme. The students would also benefit from a closer connection with "real-life practice" during their studies.

Educational processes

The teaching methods are mostly traditional, with lectures followed by laboratory sessions and literature studies and then a test or report (written or oral). A minor part of the programme is project based and an even smaller part is cross-disciplinary and integrates the other ABE programmes. A majority of the permanent teaching staff has taken courses in pedagogy, arranged by KTH, and there is an ongoing discussion about the educational processes among the college. There is a general aim to bring new knowledge and recent research within the fields of building technology and building materials into the programmes. Many lectures include case studies of real projects held by guest teachers who have been directly involved in the projects. The programmes (S programme and THUSM/TISEM) have not yet been successfully integrated within the Bologna structure and learning outcomes. The structure of the programmes is 2 + 3 years, rather than 3 + 2. This does not seem to be a problem for the 5-year "civilingenjör" programmes, but it complicates the opportunity to attract foreign students.

Learning outcomes
The expected learning outcomes are checked mainly by tests after each course. There is no information in the report about how the course analyses are conducted and how/if a portfolio system (student follow-up at programme level) is integrated into the programmes.

Student retention
The programmes started in 2005 and both the credits after the 1st year and half-way through the programme are very high. There is no information in the self-evaluation report about how many of the students who started in 2005 managed to graduate within the stipulated 6 years. With the current boom in the building industry, there is a risk that the students will find employment before they finish their education.

Graduate employability
The percentage of graduates from the programmes who had found employment 12 months after graduation is very high: 95 % or more. The vast majority of the graduates had obtained a job that matched their education and their employers found their skills to be satisfactory.

Student satisfaction
The student satisfaction level is high. The students appreciate a broad education within the field of building technology, but would like a closer and earlier contact with industry. The students appreciate that the programme, at master's level, is performed in English, but stress that this requires a good knowledge of both written and oral English among both students and teachers.

Sustainable development
Sustainable development is heavily stressed in the learning objectives, but this field is hardly mentioned at all in the self-evaluation report. During interviews, management confirmed that sustainable issues are important in the education; however, they are not very visible, either in the programme structure or in the rapport.

Internationalisation
Even though there is a fairly large number of exchange students in the programme and a portion of the student body chooses to study abroad for one semester, the international factor is not clearly visible in the programmes. The qualification seems to be tailor-made for Swedish requirements and the opportunity to take part in future work outside of Sweden is not a vital part of the programme.

Diversity and gender equity
The gender balance among the students has been almost 50/50, but the ratio of female students is declining. This should be analysed further. The gender balance among the permanent teaching staff in both programmes is 20 male teachers to 4 female. This clearly suggests a lack of female role models for the female students.

Other diversity issues, like ethnic/cultural or socio-economic background, are not mentioned in the report at all.

RECOMMENDATIONS FOR THE FUTURE

There is a rather newly appointed teaching staff that need tools, time and encouragement to work with the education at programme level.

A closer cooperation with the other programmes within the ABE (especially the School of Architecture and the Project Management Programme) would contribute to the students' understanding of their future profession.

The opportunity to create a PhD education that is more attractive to female students should be investigated further.

Feedback regarding the Bachelor of Science in Engineering in Constructional Engineering and Design (TIBYH) programme

OVERALL STRENGTHS AND WEAKNESSES

The overall strength of the programme is the combination of a practical and theoretical orientation to the subjects taught. There is a stable programme culture, which has both pros and cons. The students get a good grip of what is expected from them in working life and they get adequate jobs. However, some get these jobs all too soon and leave without a complete degree. The overall weakness of the programme is that it is run too much in isolation, even though the programme has been moved to the ABE school – for integrative reasons, we suppose. This is most visible in the lack of clarity in the connections between the degree from the TIBYH programme and the new master's programmes at the ABE school.

EAE self-evaluation process
The self-evaluation report from TIBYH was the shortest among all the reports we received. It covered only the present situation at the programme with the argument that the programme was quite recently moved to the ABE school. We did not find that argument valid, since the programme is located in Haninge and no changes of the programme's organisation or culture was visible to us. As the report is very brief, our judgement is based on the interviews with three teachers and two students. The programme manager was not present.

Neither the teachers nor the students had participated in the writing of – or had even read – the self-evaluation report. For that reason, our judgement might well be said to rely on too little information. We found this situation troublesome with regard to the dimension of the programme in the ABE school. It is a serious weakness if the TIBYH programme is too isolated and cannot benefit from development initiatives and quality processes in the ABE school.

Prerequisites
From the teachers and students we met, we think that there is a stable and quite uniform programme culture. Still, many of the teachers have been employed quite recently. The students find the content of the programme very good. The group of teachers consists mostly of men, although up to 30 % are female. However, there are some tangible problems with the course administration and course literature. For the maths courses, teachers are borrowed from other programmes. However, research links are weak and the practical aspects of the content are the dominating perspective.

Educational processes
The teachers are working systematically with different measures to support the students through the programme and the students receive help and advice on an individual level. Special support is provided for those with problems with maths. Course evaluations are carried out in a good way (smoke detecting – a good practice). However, there are quite big classes, with up to 70 students in computer rooms. The big problems for students are the maths courses and finishing the degree project. The programme structure and outcomes at programme level are not followed up. The connection to the ABE school does not seem to be utilised to its full potential.

Learning outcomes
The programme objectives are quite basic and also realistic. These outcomes are probably met – with the exception of the outcome regarding the ability to communicate in English. The programme outcomes, however, are not aligned with the learning outcomes for the degree in the Higher Education Ordinance – these are set at a higher level, especially regarding the links to research. Neither the self-evaluation nor the interviews were focusing on the actual outcomes of the programmes. The new grading scale is used for degree projects in a limiting way: only the lower part of the scale is used.

Student retention
Approximately 60–70 % of the students finish with a degree. Several factors seem to influence this: problems with the courses in maths, the degree project (writing skills) and the opportunity to get a job without a degree.

Employability
The students get jobs and are well regarded in the labour market.

Student satisfaction
The students are very satisfied with the content of the programme and the opportunities of getting a job. However, they are questioning parts of the programme structure and the administration of courses. They are also concerned with how the opportunities to proceed to the master's programmes will develop and if they will lack up-to-date information.

RECOMMENDATIONS FOR THE FUTURE

- The TIBYH programme should be better integrated in the programme structure and in the educational development of the ABE school. Could some courses, for instance, be located at KTH's central campus?
- Programme outcomes should be revised and aligned to the Higher Education Ordinance – and the consequences for courses and programme content looked into (especially regarding proficiency in English and the links to research).
- Systematic measures to increase teacher cooperation between TIBYH and other programmes should be introduced. TIBYH should be represented by the school management.
- Opportunities for students to proceed to the master's level should be considered and clarified.

Feedback to KTH management

The education should be more based on needs in society and long-term planning. At present, the strategy to select master programmes seems to be opportunity driven, where the "sale and marketing of new programmes" to achieve financial goals has been too important. This has produced many master's programmes in the engineering schools. This has resulted in several exhausting processes of change. The vision of the school has been diffuse, as the opportunity-driven strategy plays too large a role. We recommend a more stable strategy with a focus on the quality of degrees produced and the needs of society. We recommend a clear uniform strategy for both research and education. It is important to create an improved process to involve different teachers when a new education programme is planned, to ensure a uniform master's programme rather than a collection of courses with separate traditions and teaching methods. It is important that all master's programmes have a strong identity and dedicated teacher group. New methodologies and innovative learning approaches (e.g. workshops, projects) should be better used in all engineering programmes.

Five new master's programmes are planned in engineering. Several programmes will be merged. This merger will not always be free of problems. Some programmes are similar in content, such as TEESM and TWSTM, but have a different scientific or methodological base, engineering and management, respectively. To join these programmes should not be difficult as long as the engineering base is maintained.
Other programmes, such as TGEGM and TTSYM, are very different in content, but have a fairly similar base in engineering, mathematics and physics. To join these programmes can be problematic and a risk to attracting students, as these combinations are not usual and seem to provide no in-depth knowledge and added value needed to attract the best foreign students. We recommend that the new programme that is planned explores the opportunity to better combine engineering with an input of management or urban planning subjects which are both strong at the ABE school.

The school management took the self-evaluation process seriously as a way to provide better education. The school consists of many cultures and institutes of different history and practices. To some extent, the focus is on individual programmes and not on ABE as a unit, and the ABE identity therefore seems unclear. More should be done to explore multidisciplinary opportunities to form a strong level of education in ABE. The common Master's in Architecture and Engineering is a good example of a recent fruitful collaboration. These types of initiatives should be strengthened. The HI bachelor programme is well motivated to join ABE and this process should get more attention. At present, the master's opportunities for HI students are not clear. Sustainability is well integrated to the school and other schools could also benefit from this.

The CDIO process is not yet well established in the study programmes. Programme objectives need to be developed to better align to the objectives in the Higher Education Ordinance. Learning outcomes are clear in the ARKIT programme, but should be better described in other programmes. We found that the school management think that the Bologna process has been imposed upon them.

The KTH strategy should focus on providing a positive environment for both research and teaching. Top-down approaches should therefore be avoided. There is a need to develop and clarify the different levels of decision-making within KTH.

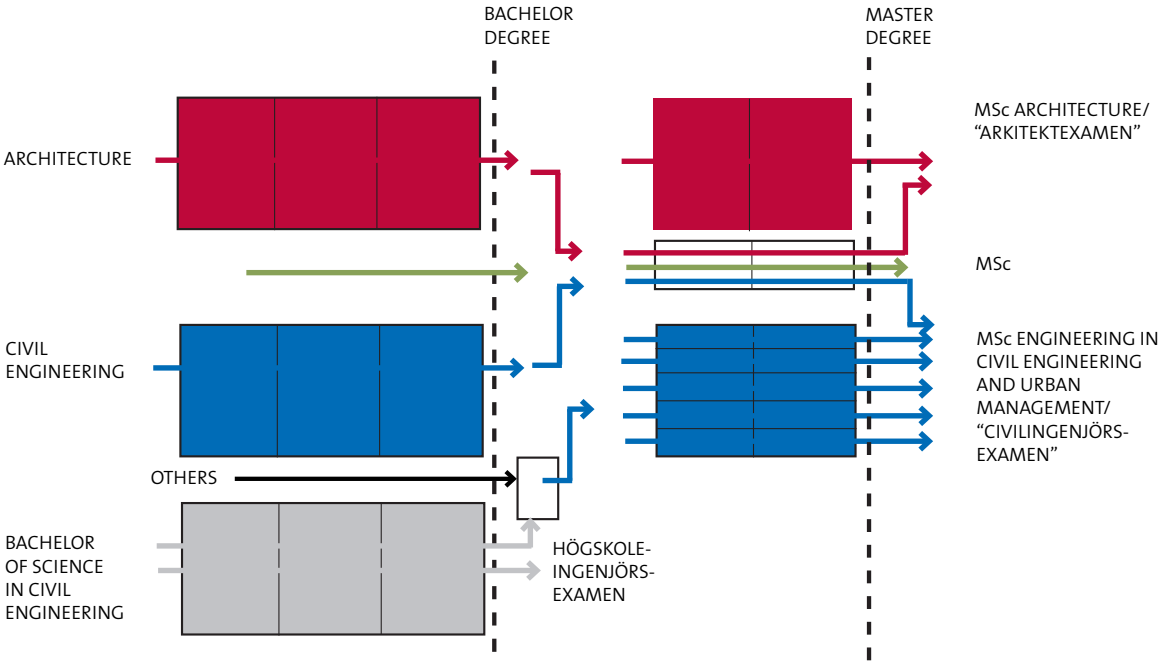
The need to develop teaching skills and also the knowledge of English are issues frequently raised by students. Consequently, KTH's efforts in the Learning Lab are very important, and the hope is that not only new teachers, especially the all too few female, but also the older teaching staff see the possibilities with it. KTH has to consider introducing a "teacher career path" directed to those who realise that they prefer teaching to research.

Feedback regarding the EAE methodology

The material in the self-evaluation reports was usually not sufficient to evaluate the programmes. We spent a lot of time reading sometimes meaningless documents. The self-evaluation report should have included a history of the school and a diagram outlining the present and future structure would have been useful. Also, course plans should have been given. Also, overall strategy plans from the schools management should have been presented. It took too long for the panel to understand the complex structure of the ABE school. There were perhaps too many programmes to review (11 master's programmes and 4 bachelor programmes).

The schedule for the visit was too focused on the input to the sub-panel. More time for reflection, discussions and writing up of conclusions by the sub-panel would have been useful. We recommend a limitation of the input and more time for discussion and writing to benefit the quality of the sub-panel working process.

The level of contact from the coordinating team was excellent. Also, the site visit schedules were well prepared. In the end, we got quite a clear view of the ABE school. In a future evaluation, a self-assessment would have also been good at the ABE school level.



Biotechnology (BIO) and Chemical Science and Engineering (CHE) Sub-panel report

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Feedback to the self-evaluation groups and school management

This sub-panel report on the School of Biotechnology (BIO) and the School of Chemical Science and Engineering (CHE), part of the Education Assessment Exercise (EAE) project at KTH, should be seen as being carried out by "critical friends" aimed at supporting and assisting quality enhance-ment. It should be stated from the beginning that the programmes evaluated in this assessment are all good, with the emphasis on building from a very good starting point.

The evaluation has to take into account, besides the true quality aspect, how to attract and keep the students focused on their programmes until the end. One serious aspect is that the competition for students over the coming 5 years will increase: first, because the group of potential students who are in the normal age range for admission to universities will decrease by approximately 30 % by 2017 in Sweden and second, because the young generation is more particular and focused on the outcomes of higher education and universities need to take account of this change in attitude. This can very quickly turn into a quality problem.

The sub-panel report is based on two approaches. The first one derives from the analysis of a series of documents received by the committee. These included general documents on higher education and external evaluation in Sweden and on internal quality assurance, local regulation and programme objectives in KTH. It also contained three self-evaluation reports: one related to three Master of Science in Engineering: Biotechnology (CBIOT), Industrial and Environmental Biotechnology (TIMBM) and Medical Biotechnology (TMBIM); another on a Bachelor of Science in Engineering (TIKED: 180 credits over 3 years) and the third on four Master of Science in Engineering: Chemical Science and Engineering (CKEMV), Chemical Engineering for Energy and Environment (TKEMM), Macromolecular Materials (TMMMM) and Molecular Science and Engineering (TMVTM). Five projects presented for master's thesis and two bachelor project reports were also provided as examples of the work developed by the students. This part constituted a good piece of information with an overview on the Swedish and KTH contexts and ambitions. Nevertheless, some numerical data were missing in order for us to fully understand the situation and be able to and propose consequent changes. After asking for them at both schools, the information was processed, but in different formats from the two schools, and given to us by the main person responsible.

The second approach taken involved extensive discussions with the school managements responsible for the programmes under review, the programme managers and teacher and student representatives. Each interview was conducted independently and was wide-ranging in the methods and questions used to clarify the situation and ambitions of this school. We would like to emphasise the quality and efficiency of the organisation, which showed a real interest in improving the system and obtaining precise suggestions from us.

It should be clarified that the panel had a large number of tools (documents, representatives and KTH's global policy) to be as objective as possible in such an exercise. The panel is conscious that it is difficult to interpret and analyse all the aspects of this task in such a short amount of time and that being fully objective is a challenge. Nevertheless, all the steps the panel undertook allowed it to better analyse and understand the content of the self-evaluation documents with respect to the positioning of the different stakeholders and to compare the opinions and feelings of each group of stakeholders with respect to the others. Therefore, it was possible to have a fairly complete view of the goals, the problems and possible solutions.

The documents received in advance were useful and facilitated the formation of an initial view on the situation and goals of the school. The panel will not comment in detail on the master's or bachelor projects presented by relevant students. In general, they are of good quality and fulfil most of the criteria corresponding to such documents. The objectives are well explained and the subject matter is developed rigorously with a good balance between results, illustrations and discussions. The bibliography seems to be complete and is well presented.

The most significant documents were the self-evaluation reports. Although they were dense, containing a large number of ideas/data and a methodological presentation, it was difficult to extract a clear and simple analysis of the existing situation with a critical view and projections for improvement. Moreover, the panel were of the view that there was an over-emphasis on the perceived weaknesses and challenges faced by the programmes and that a better balance between the strengths and the weaknesses could have been achieved in the self-evaluation reports. In addition, the solutions to the challenges, although easy to find in the documentation, were somewhat confusing. This is, in particular, the case with the bachelor programme, CHE school, which delivers a professional engineering diploma in 3 years, corresponding to industry demand. The particular features of this programme and its well-oriented goals are not sufficiently outlined. The involvement of the teachers and, in particular, the coordinator is very significant. They have succeeded in creating an attractive structure for students who wish to enter the employment market at a relatively early stage. The master's programmes, on the other hand, are "classical" master's, full of information and analyses, but could be more focused towards a more factual approach and on problem-solving skills.

With respect to the site visit, the feeling of the panel was very positive, with clarifications by all stakeholders and very frank and open Discussions on a wide range of relevant issues, including many suggestions for improvement. The reflection by stakeholders on the self-evaluation was very evident in the meetings. All aspects of the programmes were discussed: administration, pedagogy, programmes, finances, research/teaching, the teaching staff situation, international competition, employment, industry etc. The discussions on points, which were unclear in the self-evaluation reports, facilitated a much-improved understanding and clarity.

The panel wishes to acknowledge that it was received by enthusiastic and realistic stakeholders at all levels of the two schools (senior management, teaching staff and students) and that the task was facilitated by all the discussions and explanations regarding the self-evaluation.

At a general level, examples of good practice:

- A good understanding of and practice in dealing with constructive alignment in programmes.
- Two models to distribute funds with clear goals to get teachers/researchers involved in the education tasks at two schools were presented, where the CHE school presented a system with an emphasis on getting professors involved.
- An awareness of the current changes in the industrial setting towards a more specialised and knowledge-based situation. This is essential to understand what new needs and employment opportunities are behind the slow-down of big industries and the growth of small and medium-sized industries.
- Emphasis on the importance of practical elements in chemistry and biotechnology education, enabling an awakening of the interest of industrial employers, especially in small and medium-sized industries.

At a general level, suggestions for improvement:

- The organisation of KTH in terms of leadership of undergraduate education is confusing.
- The organisation of the programmes in a traditional 5-year "civilingenjörs" degree and 3 + 2 years is confusing, especially for people who are not familiar with the Swedish system. There appears to be little problem with the 3 + 2 system (in fact, we received mostly positive feedback from all levels on this point), so go the whole way and make the programme truly 3 + 2 years.
- The panel noted somewhat mixed feelings about the grading system (A–F) in general courses; however, there was a rather strong criticism on using the grading system to grade independent degree theses.
- The time and financial support for education development has to be increased.
- There is a question pertaining to the balance between scientific and engineering aspects of the education programmes. This is a genuine problem, but it lies at the heart of the education given and the staff involved must discuss this point (together with the students and stakeholders) to reach a consensus on this issue.

Feedback regarding the Master of Science in Engineering in Biotechnology (CBIOT), the Master of Science in Industrial and Environmental Biotechnology (TIMBM) and the Master of Science in Medical Biotechnology (TMBIM) programmes

The BIO school is a relatively new school within KTH, having formerly been integrated within the former "school" of Chemical Science. The programme for the Master of Science in Engineering in Biotechnology commenced in 1999 (at that time it was a 4.5-year programme, now it has been remodelled into the 5-year programme currently on offer). The programme, and to certain extent the school, was established because of demands from a growing biotechnology industry within Sweden. The school has been, and still is, very successful, with research receiving worldwide recognition. The existing programmes within the school are also very important for the research group at the school as a recruitment base for PhD students. The programmes have a responsibility to serve the biotechnology sector in the Stockholm region with a well-educated labour force. The school has, from its establishment, developed close contacts with several companies (sometimes almost an integration with the companies' research departments), and it has been a tradition to start-up companies from ideas that have been created and developed at the school. Researchers at the school have a large number of patents that form the foundation for biotechnology companies. The strength of the research and the close contact with companies can, at the same time, be a risk factor for the educational part of the school, where teaching contributes only 6 % of the yearly budget for the school.

The school has a tradition of close integration between research and education with a highly engaged programme and school management. The teachers will stay up to date with the latest findings within the fast-developing biotechnology field. The strong research part of the school has enabled the university to provide well-equipped laboratories, which are beneficial for students in several advanced laboratory courses during the master's programmes. The school puts pride in maintaining a high number of laboratory courses throughout its full programmes, where courses

during the first 3 years are mainly in chemistry and shared with and administered by the CHE school. All teachers in the BIO school are also researchers, and approximately 75 % of the teaching staff has at least one pedagogy course. There is a course formula to show how the funding is allocated, but the budget is not sufficient to deliver continuous improvement and development of the course programme and education quality. Therefore, part of the teachers' time is partly financed from research. A threat in this financing structure is that more than half of the teachers have an uncertain employment situation and are lacking a formal faculty position, which complicates the planning of the teaching staff. The panel got the impression that teaching activities are not given the same value as research merits in the career systems of the faculty staff, which is another threat in the continuous development of education. Due to the relative small size of the school, there is an informal mechanism for decision-making regarding the quality in education and teaching, which is always a focus for school management meetings. Nearly half of the students continue to study for a PhD after their master's degree.

The continuous development of the education and its programmes is organised with an active quality council that meets every month with a core consisting of the so called GA (Director for Education and responsible for quality) together with three so called PAS (Programme directors responsible for the programme management) and the head of the students office, that continuously work with quality assurance and programme development. Student representatives are invited for special topics. Teacher interactions are shared with the School of Chemical Science and Engineering, since many of the courses during the first 3 years are shared courses. Teacher interactions are organised into two lunch meetings per semester, normally with invited speakers and informal discussions, and an annual full-day workshop, all focused on undergraduate education. Regular link meetings for teachers of parallel or connected course periods are also arranged. Each course is continuously evaluated by students and the conclusions are analysed by the quality council for the continuous updating of courses and programmes.

As a consequence of the change of the previous 4.5-year programme to the present 5-year format for the master's programme in biotechnology, the programme was, in practice, changed to 3 + 2 years, where the basic level was restructured in 2007 and in 2010 the advanced level (master's programmes) was fully reconstructed into two main programmes (from previous tracks in the 4.5-year programme): Medical Biotechnology and Industrial and Environmental Biotechnology. The details of all the changes made were not presented to the panel; however, we observed that a major change was that biotechnology curricula were introduced earlier in the 1–3 years and more specific molecular biotechnology curricula were added. By this change the teacher's expressed that the students are much better prepared for the master's programmes. Basic chemical engineering is not a visible part of the curricula in the first 3 years.

During our interview, the feedback from students was that they had, in general, a high satisfaction score to the courses and that they felt that the BIO teachers, in general, were very receptive to corrective actions as a response to the students' evaluation of courses, but that the CHEM teachers were not as open to changes. What students would like, in general, is to receive more contact with industry during their education and more training/education in soft skills, such as leadership, presentation skills and economics. A difficulty for the students is the big gap in maths and science knowledge from upper secondary school, resulting in a high dropout rate early on due to too much pressure and, for some students, a high level of demotivation.

Since 2007, the first 2–3 years within the 5-year master's programme in biotechnology suffered from a high student dropout rate, similar to other schools at KTH, which seems to be a new situation for the school. During the assessment some reasons for this drastic change were discussed, such as that the industry environment has changed drastically in that the big life-science companies in the region have drastically reduced and moved out of Sweden. Students expressed that they are unclear about their future employment opportunities. The programme's management team is aware of the issue, but a better analysis of the causes underlying the poor retention (for this school) is needed. The programme management is advised to work more closely with the student group to address this problem by, for example, including student representatives as a member of the educational quality council. Some students gave the impression that they were not fully aware of the direction of the programme. For example, the BIO programme has a stronger research focus and, as already mentioned, the basic engineering curricula is no longer visible in the three undergraduate years.

A clear impression from the discussions with staff and students at the school is that there is a tension between engineering and science; the panel notes that the science aspects are generally very prominent at the school. The school management emphasised that efforts are always made to put an engineering context on topics studied, irrespective of the programme discipline (Medical or Industrial Biotechnology). Which of these aspects should dominate (or if they should be given equal weight) is a relevant problem to discuss.

The panel does not have a common opinion on this point, although we have encouraged the school to discuss this point with input from the students and stakeholders. After all, the school trains engineers, and this fact has to be reflected in the programmes.

The problem with dropout, student motivation and difficulties with the maths and basic chemistry courses are also shared problems with the CHE school, since most of the courses during the first 3 years are shared basic science courses. This has resulted in many efforts of joint programmes offered to the students to help to smooth the entry to the programme. Students can attend preparative courses in maths and chemistry before the formal start of the 1st semester, and during the 1st semester there are student workshops where guidance in chemistry or maths is offered. Since 2009, an off-campus activity is arranged where the students meet the teachers and discuss how to succeed with their studies, this is appreciated by most students.

Further to this, the BIO school presented in their self-evaluation report planned activities that an introductory lecture series, for example, should be a prioritised, and this should cover topics such as surveying the biotech industry, recent advantages in the biotech industry and biotechnology, group dynamics and leadership.

The master's theses presented to the evaluation board were all from the Medical Biotechnology master's track. They all showed a high level of alignment with the requirements set up for a master's thesis at KTH and at the school. A minor remark is that they suffer from the fact that they should be in medical biotechnology, however, the medical part often feels a bit artificial.

STRENGTHS:

- Highly engaged programme and school management teams that are committed to continuous improvement to the fast-moving evolvement of the biotechnology field.
- Close connection between education and research at this well-recognised school with a strong international reputation. All teachers are researchers, and most of them have added pedagogical training.
- The programmes are of a high quality and have kept a high amount of laboratory courses. The programmes appear to be well aligned with matching course contents between courses.
- The strong and successful research of the school has allowed for many well-equipped laboratories, which is beneficial for students in several advanced laboratory courses.

RECOMMENDATIONS:

- It is recommended that educational activities have stable finances to allow the programmes to continuously develop. Furthermore, it is recommended to have a clear career path where teaching merits are also valued. Today's underfinanced system, where research funds partly cover the education and the uncertain employment situation for many of the teachers, can be a threat to the attractiveness of teaching and may negatively affect the quality.
- A better analysis of the causes underlying the relatively poor retention level is needed. The programme management is advised to work more closely with the student group to address this problem. We strongly recommend having permanent student representatives in the quality council to facilitate this.
- In general, what students would like to get more of is a better contact with industry and applied use of the basic science courses. It is recommended to encourage the integration of introductory lectures to cover topics briefing the biotech industry as well as giving seminars to inform students about the scientific activities and technologies in the excellent research culture of the school environment.
- There is a problem with the pass rate in mathematics. This appears to be a problem in common with the CHE school programmes. It is recommended that the school's work jointly to develop the teaching format and implement examples from the chemistry and biotechnology fields. It is recommended that some "soft" skills are introduced in leadership/management and economics in order to motivate students, to increase their employability value and to broaden the recruitment base for young enterprises, which could promote the school's well-recognised entrepreneurship culture further.

Feedback regarding the Master of Science in Engineering in Chemical Science and Engineering (CKEMV), the Master of Science in Chemical Engineering for Energy and Environment (TKEMM), the Master of Science in Macromolecular Materials (TMMM) and the Master of Science in Molecular Science and Engineering (TMVTM) programmes

In this case, the panel was reviewing one of the major teaching and pedagogical activities of this well-known and recognised school. It has a large tradition, not only in Sweden, but in Europe and worldwide. This strong teaching field is, in several ways, supported by research that was deemed excellent in the last Research Assessment Exercise (RAE) at KTH.

This school, like many others, is suffering because of the decrease in activity by large industries and also because of the students' concerns about pursuing technical careers known to require constant dedication. Nevertheless, whatever the situation is, there is a need to ensure provision of well-educated and up-to-date chemical engineers as a guarantee for the future of Swedish industry. The school is promoting this vision by establishing a new open structure: "Green House Labs", with the objective of encouraging the connection between science and industry through start-ups. The panel noted the awareness of the school authorities of the challenges faced by their discipline, both within KTH and externally, in the environment of a changing world requiring new solutions and a new vision of the chemical engineer career. It should be said, in general, that the school has about an overall intake of 110 students for 65 nominal places in these master's programmes and suffers from a relatively high dropout rate, particularly after the 1st year (approximately 20–30 %). During the assessment, statistics were provided showing that after 9 semesters the retention is about 45 students, which brings the total dropout rate to nearly 60 %. The panel is aware that these statistics might not include students proceeding with their studies at a slower speed – therefore the retention rates for the master's degree as a whole would probably improve when looking over a longer period. Even if this situation applies more widely to other programmes at KTH, the panel is of the view that it is important to address the retention rate and to take corrective action immediately.

The school has introduced several actions for increasing the educational quality of which some can be mentioned: the administrative side of quality assurance, which has been strengthened by having well-established routines for all processes, such as for establishing new courses, for course evaluation or for advising students about their individual course curricula.

Roughly once per semester a "teachers' lunch" is organised, which is an informal forum both for spreading information and discussion. Once a year a small conference ("lärarinternat"), of typically two days' duration, concentrating on education is given.

Student representatives present their own regular follow-up of our courses and participate at the meetings where course evaluations are presented.

Every course director has to produce an analysis of the course each year based on the course evaluations (and other information). In this analysis he/she has to present what modifications were made to the course for the present year and their outcomes, and also what (pedagogical) modifications are planned for the coming year (based on the problems that have been addressed and discussions with other teachers and students). These analyses are read by the PA and by GA and, in case of significant problems, they may provide extra support for a course or decide to make changes to the teaching personnel. For the school as a whole, we also prepare a risk analysis that also deals with risks (and tools for reducing those) specific to educational activities.

The panel would like to make the following recommendations:

- The school analysed possible reasons for the high dropout rate of students as due to a lack of motivation and/or to difficulties with certain areas, in particular mathematics, but also thermodynamics, equilibrium thermodynamics and organic chemistry. The panel encourages the school to revise and adapt the mathematical teaching (a matter which also has been mentioned above for the BIO school), transforming it into a more attractive field useful for solving problems that are likely to be experienced by an engineer in chemistry or other fields.
- The panel highly recommends the introduction of some "soft" skills in economics and management in the first 2 years, in order to motivate the students and raise the awareness of what chemical engineering is and how it evolves and fits into the world of industry and modern development.
- Redundancies of content in some lectures could be avoided; this would allow additional time to be freed up to allow for the introduction of other topics.
- The panel encourages the school in its initiative in favouring practical projects related to industrial problems from the 1st year.

- The panel recommends that interviews with some industrial "simulation of employment" could be very stimulating for the students.
- Moreover, the early integration of students into the school and its programmes ensures that the students feel a part of the school in all its diverse activities, especially in research and laboratory work. The scientific surrounding is excellent and students would benefit from visits and contact with the research laboratories.
- Seminars and/or mini-conferences dedicated to the scientific and technological culture of the students could be planned in their curricula. The aim is to create an increased interest towards chemistry and engineering in those who feel less comfortable in the school environment and who lack information on the new society challenges (energy, environment, macromolecules, nanotechnology etc.).
- In general, the connections with industry should be deepened, including the provision of a list of possible industries for student's summer internships.
- Another important fact is that nearly half of the master's graduates go on to study for a PhD, which means that the research component is fundamental in these studies. As the research is, in the majority of cases, oriented towards the scientific/technological fields, this seems to suit the curricula. Apparently, students are interested in academic careers, but there is a growing tendency in many European countries to employ engineers with a PhD qualification. This fact is to be considered, knowing that industry competitiveness in Europe has to rely on highly innovative processes.
- Finally, with respect to the first few years, it would be beneficial, without necessarily embarking on a complete revision of the curriculum in the various subjects, to use more attractive titles to reflect appealing concepts within the courses rather than the classical ones. The advances in research and even in some industrial fields could be inspiring.

The panel considers it is very important is to continue to follow the excellent policy of the school in maintaining a high amount (200 hours) of practical work in the laboratory. It provides a very useful preparation for work in industry (most particularly in small and medium-sized industries) and contributes to the competitiveness of graduates from KTH in Sweden and worldwide.

Feedback regarding the Bachelor of Science in Engineering in Chemical Engineering (TIKED) programme

This bachelor programme has particular features and is addressed to students wishing to become operational engineers in 3 years. In general, students are a bit older (around 25 years), and the students the panel met seemed to be highly motivated. The programme, including "soft" engineering skills, is diversified and very well structured. The students are satisfied and aware of the interest by employers of such graduates. From the 30 students who started the programme, approximately 60 % graduated with their diploma. However, an additional 20 % finished their studies but did not take their final examination. The reasons for this seem to be diverse, but it is often the case that such students do find, relatively easily, employment in different fields, and within one year after leaving 95 % are employed in positions that are relevant to their qualifications. The most active teachers are lecturers and they do not take part in any research activities, as their teaching and administrative workloads are very heavy. Other teachers are professors or assistant professors and are also doing research.

Students are given a picture of the professional role through seminars, meetings with engineers who have already graduated, study visits and, not least, through real problems, examples and projects in these courses.

Students are encouraged to reflect on their learning by writing a log.

Different ways are proposed to get students to use the literature, since it provides deeper understanding and training in finding relevant information. One method used in some courses is to let students use the literature during their exams.

The teacher group has started a pedagogic project where they will visit each other's classes and participate in the collegiate development discussions.

The panel noted some difficulties and wishes to suggest possible solutions:

- A stronger level of recruitment is required. It is recommended that KTH's website is used to communicate more widely with external audiences, including potential students, with a clear presentation of the opportunities offered by this degree and its close relationship to meeting industry demands.
- In parallel, the contacts with industries should be deepened, facilitating interaction with industrial problems and internships in enterprises. A systematic view of possible industrial partners would consolidate the diploma.
- As the lecturers have a strong dedication to teaching and pedagogy, it would be important to offer them the opportunity to develop their capacities in other fields of the school and KTH. They could develop pedagogical research, which could give them the opportunity of pursuing a full university career.
- The stabilisation and support of the teaching staff is highly recommended. In effect, the situation of this category of teachers is fragile because they are not researchers and not recognised in the classical education system. Nevertheless, its strong implication in pedagogy should be exploited in the sense of developing research in the field of the pedagogy in teaching.
- It is up to KTH not only to support and encourage such "professional" diplomas which correspond to a real demand in the labour market, but also to encourage the professors to become more actively involved in this activity.
- It is also recommended that the school integrate this bachelor programme, considering it as a real contribution to a society demand, at least in the short and medium term. The industrial demand and needs evolve rapidly, and such approaches need more insight and more interaction with the core of the school: a master's combined with research and industrial activities (contracts, internships).

Lastly, the bachelor programme dedicated to short Engineering studies and forming Engineers directly for the industrial labour market, equipped with practical skills and adaptable to a changing industrial situation, should be consolidated by the school. There is a need to stabilise and support the teaching staff dedicated to this programme and to encourage them to engage in pedagogical research, and this bachelor degree should be seen with more "pride" by the school.

Programme	University	Nominal places	Overall intake	Credit increment straight from upper secondary school
Chemical Engineering	KTH	40	82	14.10
	KTH Intl*	25	32	19.04/15.82/ 18.36
	CTH**	60	67	18.60
	Lund	60	69	18.20
Biotechnology	KTH	60	85	18.89
	CTH**	75	85	19.15
	Lund	60	69	19.36
Industrial Economy	KTH	120	160	21.50
	CTH**	100	110	21.72
	Lund	100	123	

All figures are from "Verket för högskoleservice" official website on 26 August 2011.

*KTH Intl, under Chemical Engineering, refers to the three admission groups for the 5-year chemical engineering programme: International, Chinese and Japanese. For admission credit increment the figures are split into the order as above, but for nominal places and over intake they are combined. Entry test admission is not included, where the pattern is even further pronounced.

**CTH , Chalmers University

Brief conclusion

The School of Chemical Science and Engineering has a strong tradition in Chemical Engineering applied to several fields. It has at the same time historical boundaries with Swedish industry, but needs to adapt to an evolving situation in Sweden and elsewhere where small or medium industries are replacing large industries. The high level of research should be considered as an advantage to follow up the present changes and produce engineers that are adaptable and creative in the sense of enterprise. The programmes which are, in general, interesting and good should allocate more space and time to the teaching of "soft" engineering skills, such as economy, management, knowledge of industrial issues etc. At the same time, basic fields, such as mathematics, should be more focused on the requirements of the Engineering disciplines. The panel is of the view that the school has all the potential to overcome the present challenges.

The panel thinks it is important to comment on the required credit increments from upper secondary school for admission to the 5-year programmes offered by the evaluated schools. For both schools, the lowest credit for admission is lower for KTH when compared with the two other "old" technical universities in Sweden: Chalmers University of Technology and Lund University of Technology (the latter a faculty within Lund University). In the case of biotechnology, the difference is only minor, but for Chemical Engineering the difference is significant, see the table below, where Industrial Economy is included for comparison (a very popular programme in Sweden). These differences have to be analysed. The panel is aware that the comparison can hide differences in policy for over intake between the three universities, with a much higher over intake for the CHE school at KTH compared with other universities.

However, these figures are the ones that potential students will read as official (this group of potential students is not aware about different university policies about over intake and how the official credit increment is presented). During discussions with students from both schools, the panel commented on admission credits. Surprisingly, a large number of potential students seem to use their upper secondary school credits to apply for the most difficult programme they could. Very few students expressed that they applied to the programme because they were dedicated to the subject.

A comment from the panel to the Chemical Engineering programme management is that the high over-intake, which the other programmes at CTH and LTH do not show (they probably solve this matter in another way), will lower the visible admission credit, which reflects the credit of the last student, but is not necessarily representative of the overall group of students. Another observation made during the assessment is that an increase in over intake in chemical engineering does not seem to result in a higher student retention number – they were all levelled out at around 45 students after 9 semesters, regardless of the increase in over intake from a total of 75 students in 2002 to 110 students in 2006. A decrease in the over intake will probably improve the admission credits and thus could be one of several tools to regain the attractiveness of the programme.

We strongly recommend the school to analyse how to prevent dropouts and how to keep/increase the admission credit increment from high school. This is strongly recommended in the light of the fact that the group of potential students for university studies will certainly decrease over the coming years. The school has to plan and act now.

Feedback to KTH management

In general, for both schools (BIO and CHE): parity of esteem for teaching and research seems to be difficult to achieve at KTH. It is clear that rewards (e.g. promotion, funding) are allocated primarily for success in research activities. There is a clearly defined career path for research, but teaching is not addressed sufficiently well.

The education is under-financed and, in practice, supported by research grants. This is a situation common to most higher learning institutions in Sweden. There are two issues one has to consider on account of this fact. First, insufficient funding puts making priorities high on the agenda. KTH should react by funnelling as much money as possible into direct teaching activities (lectures, exercises, practical moments etc.). A prerequisite here is knowledge about where the money received by KTH for teaching is actually used.

Second, one needs to make a strategic decision whether this is a reasonable situation or not. From the point of view of teaching quality the answer is clear. From the point of view of sending signals to the political sphere, it is perhaps less obvious. At any rate, the problem should be discussed within KTH.

The question on how and in what form sustainable development should be included in the curricula was not a prominent topic during the discussions with representatives of the evaluated schools. At present, different stakeholders would like to introduce a number of topics into the curricula of higher education. This can, in many cases, be justified, but it must be balanced against the content of the "traditional" academic disciplines. A prerequisite for a successful introduction of, for example, sustainable development is that it is dealt with in a context of the core disciplines. For instance, in a chemistry education the chemical aspects of sustainable development must be addressed in the various chemical

sub-disciplines. However, the panel was presented the fact by the students, especially at the CHE school, that several lectures started with a short introduction about climate change.

The panel would like to quote one of the interviewees during our visit to KTH: "The management of KTH should show less formality and be a bit more flexible". This points to the issue of finding a right balance between control and trust: not an easy task to handle indeed.

Finally, the panel would like to underline the fact that the programmes evaluated are good programmes, but there are several risk factors identified. If these are not taken into account there is a high probability that the standard of the programmes will decrease.

- Both schools have to analyse and plan for the future regarding the retention of students. Also, both schools, especially the CHE school, need to immediately address, the low admission credits (in comparison to other programmes and universities). The latter may also be valid for the BIO school if it does not prepare for the future.
- Both schools have to defend the amount of laboratory work in all their programmes, which gives the students a true competitive edge in applied practices. Students attending chemistry and biotechnology must have a broad knowledge in laboratory work, but, in addition, they need to be skilled in the area.
- Both schools have to plan for the "in-subject motivation" of students. Several basic courses could be identified by the panel as highly questioned by the students, especially the courses in mathematics. We recommend adapting the mathematical teaching, transforming it into a more attractive field, with applied examples useful for solving problems found by an engineer or scientist in the Chemistry- and Biotechnology-related fields. In the future, students will probably be even more demanding regarding their levels of motivation.
- The panel highly recommends introducing some "soft" skills in leadership/management and economics in order to motivate students, to increase their employability value and to broaden the recruitment base for young enterprises, which could promote the school's well-recognised entrepreneurship culture further. The investment in the "Greenhouse Labs" at the CHE school is especially recognised by the panel as being an excellent strategic decision for the future attractiveness of the school that should benefit from a stronger entrepreneurship momentum in the educational programmes.

Both schools should be encouraged to prioritise thoughts and plans in integrating in their curricula seminars and/or conferences to inform students of the scientific and technological activities in the school environment early on. We recommend that such initiatives are fully financed to allow for prioritising and further developing plans that are already available but are not yet activated. This is to overcome the students' lack of understanding on the "use" of the heavy basic curricula in the first few years. Both schools have excellent research in several fields, which is well recognised worldwide and the students would benefit from visits and contact with these research laboratories. The aim is to share information and to create a feeling of passion about scientific and engineering aspects of their fields in those who have no information on the new enterprise environment outside the school system. Decide on the continued strategy for how to support and encourage the "professional" bachelor programme, which corresponds to a real demand in the labour market as measured by the high employability level.

Feedback regarding the EAE methodology

Overall, the review was organised excellently well and very efficiently managed. Everything was very smooth with excellent timekeeping and management of interviews and other activities. The panel did note that the timetable for the second full day, which included meetings with stakeholders in the School of Chemical Science and Engineering, was an improvement, in that small amounts of time were allowed between meetings. These periods allowed the panel to exchange views and to reprise the key points of each meeting before moving on to the next. The panel found this very helpful in their deliberations.

Holding all panel visits in the same week also worked very well. The single briefing by senior management to all the reviewers was efficient and informative, as was the open question and answer session.

The panel lacked statistical data, for instance regarding student retention rates etc. It also turned out that it was difficult to produce such material during the site visit. Moreover, we got the impression that different standards were used to measure things like dropout rates between the different programmes at KTH. This points to two problems that need to be addressed. First, to develop ways to produce key figures pertaining to the education programmes and second, to make sure that these key figures are used uniformly over the different schools at KTH to allow for comparisons.

We got the impression that the outcomes of the EAE project had not been clearly defined for the staff at KTH.

A quality review may set rather powerful forces in action at a university. It is this panel's opinion that a necessary condition for a positive outcome of a quality review is that the reasons for performing it are well defined and that it is clearly communicated how the results will be used.

The panel noticed that the procedure to nominate student representatives for the BIO and CHE schools was different. In the former case the students' union was responsible for suggesting students, while in the latter case, students were nominated by the responsible teacher(s). The proper way of nominating is through the students' union. It was quite clear that the emphases of the students' views were different in the two groups of students, reflecting the difference in how they were nominated.

We also lacked international students in the student groups. Opinions of international students would have been useful, not the least in the context of the outspoken aim of KTH to be an international player in higher education.

Finally, we note that the use of independent degree reports to judge the quality of a whole programme is an impossible task. Since this is a cornerstone of the new scheme for judging quality, as developed by the Swedish National Agency for Higher Education, this comment is perhaps more directed towards this agency than to the management of KTH!

To summarise, the panel would recommend a similar approach to this type of review if conducted again.

Computer Science and Communication (CSC) Sub-panel report

Lauri Malmi (Chairperson), Aalto University
Susan Eisenbach, Imperial College London
Rune Hjelsvold, Gjøvik University College
Arieh Iserles, University of Cambridge
Kerstin Johnsson, Lund University (student representative)
Johan Malmqvist, Chalmers University of Technology
John Tucker, Swansea University

Feedback to the self-evaluation groups and school management

In this evaluation exercise, we carefully considered the self-evaluation report and many additional documents that were provided to us in the information pack, as well as before and during the site visit. We met many faculty teachers and students during the site visit. We, however, fully recognise that this rich information we received may not reflect the full picture of activities in the school and the degree programmes. We therefore emphasise that the following critique and recommendations should be carefully discussed with all faculty members in the school to validate it and to discuss its relevance and possible actions needed, either at programme, school or KTH level.

EXAMPLES OF GOOD PRACTICE AND ASPECTS THAT ARE PARTICULARLY INNOVATIVE

- The school organises regular pedagogical seminars for teachers, which supports the reflection of current education and discusses new approaches.
- The Directors of Studies give support to teachers.
- There is transparency of teaching commitments among teachers.
- There are good relations between the faculty and students.
- The facilities are good.

ASPECTS THAT REQUIRE CORRECTIVE ACTION AND ASPECTS THAT MERIT SUPPORT STRATEGIES

The faculty seems to be disempowered and passive about what goes on in the teaching programmes.

We got the impression from non-senior staff that there was no awareness of a strategic vision about what programmes should be providing. The senior staff assured us that there is a new strategic vision, but did not elaborate on whether this vision addressed education. Even so, we believe that the strategic vision of the school should originate in the entire school rather than just from senior management.

Recommendation: The school management should engage the entire faculty in a discussion on strategy and future vision. The strategy should address the aims, scope, focus and pedagogy of the school's programmes.

Recommendation: As a part of strategy work, the school management should take a look at the proliferation of programmes, especially at master's level, and decide whether some of them should be removed or merged.

It seemed to us that the school has been run by a spreadsheet mentality, i.e. strictly counting what the responsibilities of each faculty member are and how much time each of them has been allocated to carry out these tasks. This is detrimental to change, creates an inflexible atmosphere and impedes initiative and a "can do" spirit; the creation of first-rate teaching and research programmes requires change.

Recommendation: The school management should discuss with the faculty whether this impression really holds and what could be done. Management should promote initiative among teachers and do its best to overcome possible difficulties in implementing changes, if they are considered appropriate at programme level.

As the MSC theses are the culmination of the degree programmes, we feel that it is critical to get them right, and we have several serious reservations about them. It was difficult for the panel to find out information about thesis work requirements and process, and the students said that they too had difficulties finding information (which does exist).

The examples of independent degree projects provided to us (in the information pack) were at MSC level and were disappointing in subject matter and quality, e.g. project topics presented did not match the scope of the degree programmes, there was weak coverage of literature in several sample projects and the tasks undertaken were not always as substantial as would have been expected for a 30 ECTS piece of work. The selected sample of projects did not all meet standards of adequate MSC theses.

Only during the site visit did we discover that programme leaders do not always have knowledge of their students' theses that have been carried out in other schools or an interest in monitoring their appropriateness to their programmes. This seems to us to be a clear weakness: there is no control of what project topics are formally allowed for CSC-related degrees.

During the site visit we were provided with a much more appropriate set of thesis reports from the school management, a set which reflected the work carried out in this school. In this set the topics were appropriate for a CSC school. We, however, were still concerned that there were accepted theses which did not seem as substantial as would have been expected for a 30 ECTS project, including a proper literature survey.

We investigated the grade distribution of thesis works in the computer science programme (2010–2011), and we were concerned by the very high percentage of theses with high grades: 41 out of 50 theses that had a grade A–E (there were also 63 theses with a "Pass" grade) had the best grade, A.

Recommendation: The school management should implement procedures which

- Easily provide students with accessible written information about thesis requirements, process and grading.
- Ensure that CSC programmes have a clear control of thesis topics which are acceptable in the CSC school. We understand that there are cases where it is appropriate for CSC students to carry out their projects in other schools. These cases, however, have to be clearly identified in the process, as well as in any statistics related to school results. There must be the recognition that, even if the thesis is supervised elsewhere, ultimate responsibility for quality assurance resides with the school, specifically with the programme directors.
- Reconsider carefully reconsider the grading policy of thesis projects with all faculty members who are allowed either to supervise or examine thesis projects:
- Re-evaluate the independent degree project grading scheme in order to increase the differentiation of thesis grades. Consider the weighting of the dimensions process, product and presentation, as well as the rubrics within each dimension.
- Review programme requirements and contents to ensure that all students have the appropriate pre-knowledge prior to starting their independent degree projects, including advanced-level subject matter knowledge, literature search skills and writing skills.

It seems from our meetings with the faculty, meetings with the students, the prizes won by the school, and the statements of the school management that teaching of individual courses is taken very seriously. We, however, found no evidence that the programme design receives any similar kind of attention. Having the programme directors chosen primarily from the junior faculty does not give a positive impression of the commitment to teaching. It seems to us a clear weakness that teaching leadership roles in a world-class department are not held by the senior research-active faculty.

Recommendation: The school should reconsider nominations of programme leaders and nominate them from the senior (professor level) faculty. We are aware that the CSC school has lower proportion of full-time professor positions compared with other KTH schools, and this would be an incentive for KTH to increase their number to avoid overloading current professors with excessive responsibilities.

There is a very serious problem with the availability of information on the web about both the school and the teaching programmes. At this time, the only reasonably effective way of finding information seems to be via an external search engine. The entire EAE CSC panel found the website opaque, often facing a mix of languages (Swedish/English) in which information is given. For example, we did not find clear information about the overall structure of degrees provided by the school. Given that this is the main avenue for potential students, other researchers and HSV to find out about CSC, we cannot overstate how important it is that the website be replaced by one which reflects the work that goes on within CSC in an easily accessible way. As an example, the panel assumes that the roles of Vice-Dean of Education, Director of Undergraduate Studies and Programme Directors are probably clear for the current staff. However, it would also be good to make the roles more visible, through the school website, to people from the outside.

There was a discussion about corporate branding and whether the problems lie in KTH internal web information policies. However, the problem lies within the school and must be solved at school level.

We hope that the new Dean of CSC's initiative to redo the website is effective, but are concerned that the school has not put sufficient resources into providing an informative website in the past.

Recommendation: The school should follow the initiative carefully, and, if necessary, should be provided with appropriate resources from central level.

The merger of the HCI and Media Departments is an important step for the school and should lead to new developments.

We recommend that the Media Technology programme is given particular attention. It needs to have (i) a coherent mission, clearer educational objectives and focus and (ii) a firmer research base.

Recommendation: Efforts are made to support staff in developing their research competence and qualifications (PhD, docent), and the search for a new Chair is a priority task.

Course evaluations are not always presented to students. Student representatives never get to see them aggregated so that comparisons between courses and comparisons of a course over time can be made. Even though the programme as a whole is discussed in the programme integrating course, no statistics regarding student satisfaction and student retention are presented. Thus, the feedback at programme level is lacking.

Recommendation: Course evaluation results should be summarised and made available to students, and especially students' union representatives. Aggregated results for the courses in each programme should be presented to and discussed with students' union representatives.

There seemed to be some lack of clarity among the junior faculty in how decisions are made for programme changes. Some teachers complained of the time lag between requesting a change and when it can be implemented. The administrative constraints on change encourage inertia.

Recommendation: All faculty members should have a clear understanding of how to proceed when they see a need to change their course in some aspect. Possible problems with updating the national course information database (LADOK) should be overcome at school level.

Feedback regarding the Master of Science in Engineering in Computer Science and Technology (CDATE), the Master of Science in Computer Science (TCSCM) and the Master of Science in Machine Learning (TMAIM) programmes

STRENGTHS

We observed that there seems to be good collaboration between staff members and students. In particular, the students seemed happy with the general attitude of staff members. "They are eager to listen to us and what we say", we were told.

The lecturers whom we interviewed had obtained research money, which enabled them to do substantially less lecturing. Yet, they had decided to do more teaching than required, because they enjoyed it and were committed to the students.

The panel considered the regular practice of course evaluations and discussing courses with their peers in small groups a good practice.

Annual meetings with the Director of Studies were also useful. Academics particularly liked the fact that every teaching task was allocated a time allowance, and so people's teaching commitments were transparent. They also liked the fact that the derivation of the tariff for each task was an iterative process over years and seemed to believe that the current tariffs were fair. In spite of these positive aspects, we felt that sometimes this time allocation is bound to cause unnecessary inflexibility in the organisation: if time is not allocated for a certain task, some people may consider it unnecessary to accomplish it.

We interviewed a new lecturer who felt that the 15 ECTS pedagogical course helped her to settle in, in several ways. She enjoyed meeting other new lecturers in other schools, as this made her feel a part of the KTH community. The coursework requirement about self-reflection gave her a greater insight into her teaching. Some of the course material was interesting and gave her ideas for her teaching.

From both the documentary evidence provided and the interviews with the chosen students, the degree programme seems to meet the students' expectations. They find the academics in the school responsive to their needs. There is a mixed reaction to the mathematics lectures. Some students do not understand why they should be required to study this material, especially certain mathematics content that they felt was not used in their programme.

Students have an opportunity to reflect on their studies in the programme integrating course. This course also seems to support programme development by giving feedback to the programme on a holistic level. The interviewed teachers seemed to appreciate it.

We have identified that there are innovative approaches to education in the CDATE programme. As an example, we take the "Programming Under Pressure" course, which is combined with the activities related to programming contests. The programme invites students to participate in both national and international programming contests, and there have been clearly successful results. We consider this to be a positive and motivating factor for students interested in developing their programming skills.

There is some work going on in computing education research, where the active development of education and educational tools have led to scientific work. This is a development that should be encouraged, especially in cases where developing educational technology may bring forward interesting computer science problems to be addressed in other research groups.

In addition, taking a research perspective of developing education can support better teaching and learning and provide evidence of the achieved improvements.

We recognised the high employability of the students.

WEAKNESSES

The bachelor degree project in the CS programme is organised as a course consisting of a lecture series, a group project in 10-student groups and an individual project. The size of the independent project is 9 ECTS. This is a questionable set-up with regard to the Swedish national requirements for bachelor degrees, which calls for a 15 ECTS independent degree project. It can be debated whether the students meet the bachelor degree requirements.

Recommendation: Decouple the group project from the bachelor degree project. Create a dedicated group project course and let the bachelor degree project be done individually.

We did not find enough evidence to conclude that the programme addresses sustainability issues properly.

Recommendation: Consider whether this could be addressed with a specific (compulsory) course or by incorporating sustainability issues in some of the current courses.

Students noted a specific course related to software engineering, the contents of which need to be revised to match current standards, and there seemed to be an inadequate response to this request from the organisation.

Feedback regarding the Master of Science in Engineering in Media Technology (CMETE), the Master of Science in Media Technology (TMETM), the Master of Science in Media Management (TMMTM) and the Master of Science in Human-Computer Interaction (THCIM) programmes

STRENGTHS

Media Technology includes physical media (for image + video + audio), software for communication (e.g. for web + mobile + spatially aware devices), management business development and legal and governance matters. Media technology seems destined to be a large and influential field of study and an economic sector. The engineering approach to media is being developed effectively. The technical nature of the programme is important, combining basic subjects of software, mathematics and physics.

The media and HCI programmes stand out as they have a high female participation: such as CMETE (c. 40 %) and TMMTM (c. 50 %). This was reflected in our meeting with students (80 %).

The media programmes created the programme inte-gration course, and its beneficial effects have led to it being adopted by other programmes. We found that the course has a good response from students and teachers. We question whether its contents are worth 7–13 ECTS. We wondered if the same learning goals could be achieved in other ways with less ECTS? Could the expected learning outcomes be extended and the requirements for passing the course be strengthened intellectually?

The programme attracts students who would not otherwise come to KTH.

Students seemed generally happy with the level of education and the teachers. However, there were complaints regarding the quality of teaching of mathematics (although not the relevance).

Teachers were positive towards education and developing it.

Students were very positive about the opportunity to complete their MSC thesis in a business setting.

WEAKNESSES

Building academic competence and capacity in new broad areas is often a multidisciplinary and volatile process. We have questions regarding the standard of education compared with other programmes at CSC. Its considerable breadth requires the programme to compromise on depth; some topics that are intellectually challenging in an engineering context may take on shallower forms in this course. This is also apparent in the learning outcomes (programme objectives) defined for the media and HCI programmes – none of the specified learning outcomes require the students to demonstrate substantially deeper knowledge in certain parts of the field as specified in KTH's new educational framework. It is hard to see what the core of the programme is and what true expertise the programme produces. The only courses that are compulsory for all students, across their selected specialisation, are the non-technical media courses. We had difficulties understanding the logic of the programme beyond being a collection of mostly introductory courses.

Recommendation: The media technology staff members should initiate a discussion to address these issues in order to develop a coherent view of the programme goals. They should ensure that students gain a deep knowledge of certain focused topics during their studies and meet the national requirements of a MScEng ("Civilingenjör") degree.

The Media Management programme extends the school's scope and we wonder whether CSC is really the right place to develop this type of programme in the future.

Should KTH consider developing a School of Social Sciences for Technology for such a programme or should it be located in the School of Industrial Engineering and Management?

The research foundation of the media programmes seems weaker than others that we have evaluated. This might be due to the fact that a significant number of the staff does not have PhDs and that Professor Chairs are currently vacant.

The school management and the programme management are all new. We did not recognise that the school and the programme management have a clear vision for the future development of the programme, what it should be in the future. Apparently, the school and the programme management are waiting for the vacant Chairs to be filled before initiating the work to define such a vision for the programme.

Feedback regarding the Master of Science in Scientific Computing (TSCCM) and the Bachelor of Science in Simulation Technology and Virtual Design (TSVDK) programmes

STRENGTHS

The research group supporting the programme is, scientifically, highly regarded internationally. This is a young group with prominent research profile.

A palpable enthusiasm exists among the academics concerned to share their expertise with students within the programme and within KTH.

Teaching of numerical analysis throughout KTH is evidently at a higher level than service teaching of "standard" engineering mathematics.

The recently introduced tutoring system is a definite strength and a positive development, although we note that its implementation is hampered by budgetary constraints.

WEAKNESSES

The size of the incoming student cohort is alarmingly and unsustainably small. This is a serious weakness that must be addressed promptly, without awaiting eventual outcomes of the new proposed undergraduate course.

Recommendation: The programme managers should be considerably more proactive (and given the scope to do so) in advertising the programme.

There are worries about the level of students who are accepted for the master's programme, particularly regarding their mathematical proficiency. The efforts to solve this problem have been completely unsuccessful. The programme falls short of equipping students with the range of competencies that are useful in an industrial career, e.g. mathematical modelling and the basic know-ledge of engineering subjects.

Recommendation: Open up the curriculum so that it is easier for students to complement their scientific computing knowledge with the knowledge of an engineering subject of their choosing. Address "industrial mathematics" in some courses or projects.

The likely success of the proposed 3-year bachelor programme "Simulation Technology and Virtual Design" is questionable. We are not persuaded that, in its proposed form, duration and name, it will attract good students from Sweden in the right numbers.

Recommendation: Reconsider the decision to launch a 3-year bachelor programme, and replace it with a 5-year Civilingenjör programme with "mathematics" in its name.

We are not persuaded that the programme has sufficient core material in scientific computing. For example, there is no mention of optimisation or stochastic computations in the syllabus.

Recommendation: Revise the curriculum so that it enables students to develop knowledge of mathematical topics taught by the Mathematics department, including optimisation and stochastic computation.

The sample MSC theses were uneven, weak and sometimes methodologically unsound.

Recommendation: Form a working group that reviews the quality of master's theses from the programme.

The relationship of this programme with the Mathematics department is totally unclear. The historical circumstances for being in the CSC school are not a valid reason anymore and, ideally, scientific computing should be repositioned to the School of Engineering Sciences as a division of the Mathematics department.

Feedback to KTH management

The range of subjects at the CSC school has to be at the centre of modern engineering, and if KTH is to be a relevant 21st-century technical university it must have a world-class school in the information area.

At KTH, the structure of both the schools and the departments within the science and engineering schools seems to be historically rather than intellectually based. There seems to be quite some overlap between the schools of CSC and ICT. Merging these two schools would strengthen KTH's position in the areas of CS and ICT, would make KTH's study programme offerings appear less confusing to prospective students and would potentially result in increased efficiency.

Given KTH's and the School of CSC's expertise in telepresence, through the Centre for Sustainable Communications and the Media Technology and HCI department, it should be possible to merge the two schools without having to relocate students or staff from any of the two sites.

Recommendation: KTH management should set up a process to provide a strategic vision for the information area. This process should have academics and students working at the CSC/ICT at its core and pay attention to what happens at the best institutions around the world.

Our perception is that the decision-making structures at KTH are excessively administrative and top down. Decisions appear to be fundamentally managerial, rather than strategic in nature, and are arrived at the centre and filtered down to schools and then to department and educational programmes. The units down the "managerial chain" have very little scope for their own action and initiatives. Specific examples include:

The structure of units is concerned more with administrative convenience and geographic proximity than with scholarly and pedagogical rationale.

It seems that the schools and departments are excluded from decision-making process in hiring their own academic personnel.

A system of advancement and promotion that has little to do with school contribution or initial school filter, which inevitably leads to neglect of teaching quality as a necessary condition for promotion.

Centralised control over the dissemination of information on master's programmes, inclusive of both printed and web-based literature, is detrimental to proper communication of information to potential students, and this may be reflected in student numbers.

The consequence of such examples is that schools and departments inevitably feel disempowered and their initiative is sapped. Academics operate at their best when they have full scope to exercise their judgement and responsibility, rather than being cogs in a machine over which they have little control. Our impression is that at all levels of CSC there is considerably too little initiative and readiness to assume responsibility and too much passive acceptance of instructions from above. In our experience, the best academic practice in leading academic institutions is centred upon a substantially more decentralised structure.

Recommendation: We encourage KTH management to evaluate how well its centralised structures and policies provide the services that academics working in KTH schools need as support functions. This should be carried out in close collaboration with schools, possibly also with external evaluation panels.

Feedback from student evaluations exist, but it is not as pervasive as it needs to be. The course evaluations have several omissions which need to be rectified.

The information is between lecturer and students only. The results are only made visible to the students or other faculty members if the individual being assessed decided to allow this.

There is no information provided across programmes or across years.

Recommendation: Problems at programme level and repeated difficulties need to be better supported by the student evaluation system.

Student representatives for external courses are not organised, which makes it especially hard to influence courses outside CSC. The students' union does not seem to know how to react when it tries to improve these courses.

Recommendation: KTH should better support and monitor the evaluation of service courses, i.e. courses given to other programmes from any KTH school.

On all levels, we saw little awareness what happens at competitor institutions.

FEEDBACK REGARDING THE EAE METHODOLOGY

The EAE process demonstrated that there were structural problems with the preparation and changes need to be made before the National Review. The school had no clear idea what information the centre had sent us. The school should have a more active interest in and possibly have a final say over the material that is released in its name.

At academic staff level there was very little understanding of what the EAE was about. For the National Review, all the academics at KTH have to know what the review is about and what its goals are. One would expect practice runs before the final visit.

The original information on independent degree projects and how they are organised was quite insufficient for the panel, considering the importance of these project reports in the future national evaluation. It turned out that the selection of project reports given to us was almost totally from projects supervised outside the CSC school, thus poorly reflecting the school practice and levels.

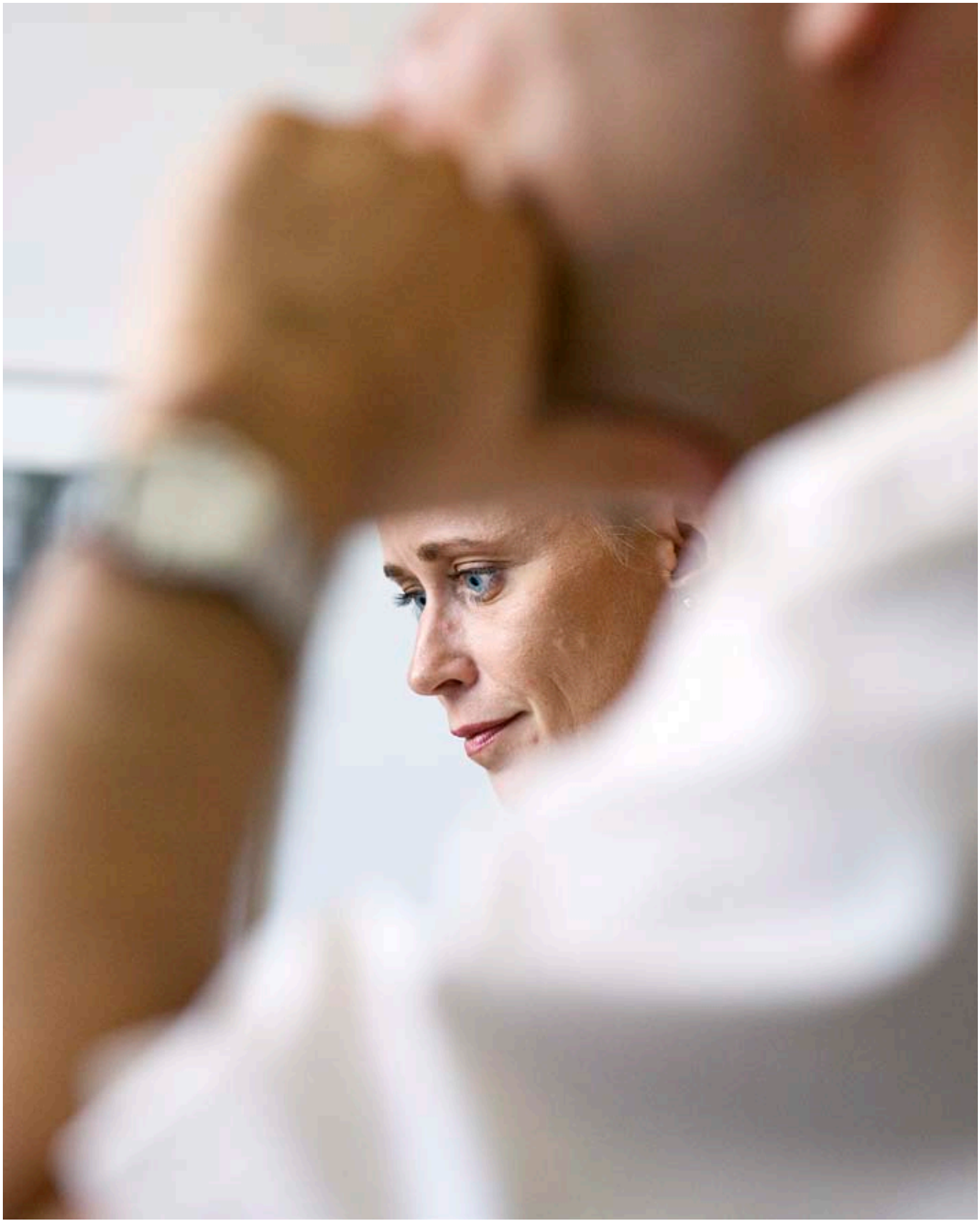
Recommendations This kind of teaching evaluation should definitely be academically driven instead of managerially driven. The academics are the primary group to fully recognise and address the problems of education.

There must be a much more careful plan for preparing for the upcoming national education evaluation, including:

Informing academic staff and students about the goals and operation of the evaluation.

Preparing the material that is provided for the evaluation panels in collaboration with academic staff.

Reviewing and refining the material, ensuring it addresses the review questions properly and holds a uniform high quality across KTH.



Electrical Engineering (EES) Sub-panel report

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Feedback to the self-evaluation groups and school management

CONTEXT

The EES sub-panel was asked to review five Master of Science (120 credits, 2 years) programmes and one Master of Science in Engineering (300 credits, 5 years) programme offered by the School of Electrical Engineering at KTH. Of these, the Master of Science in Engineering in Electrical Engineering belongs to the traditional "civilingenjör" track, albeit with a recent alignment of the curricular structure to accommodate the Bologna model of a 3-year bachelor degree followed by a 2-year master's degree. This programme has primarily targeted domestic students who enrol in the programme at KTH throughout their period of study. With the revised 3 + 2 study plan, the programme is now, in principle, catering to students with bachelor degrees from comparable programmes entering the KTH programme at master's level.

The 2-year Master of Science programmes considered by the EES sub-panel all originate from so-called international master's programmes whose primary target for recruitment has been with international students seeking a globally competitive degree. Before the introduction of tuition fees, these programmes were additionally attractive due to their relative low cost of study compared with non-European universities, primarily those in North America. Indeed, some subsets of students might see such a programme as a springboard for further study at the doctorate level at a North American research institution.

With the adoption of the Bologna model and with the introduction of tuition fees, there is greater need for convergence between the 3 + 2 Master of Science in Engineering programme and the 2-year Master of Science programmes, allowing students in the 5-year programme to select their master's-level course of study from any one of the 2-year Master of Science programmes. This imposes constraints on the curricular study as well as on managing the expectations of different cohorts of students.

These changes form a structural backdrop to some of the content of the self-evaluation reports and the material shared with the panel during the individual interviews.

PREMISE

In preparing for the site visit as well as in preparing this report, the EES sub-panel made extensive use of resources provided to it by the KTH EAE staff as well as resources obtained from publicly accessible websites at KTH and the Swedish National Agency for Higher Education (Högskoleverket, HSV). In particular, the sub-panel sought to examine the coherency across all different available sources of information of the programme structures, programme objectives and quality assurance processes. This included contrasting the national qualification descriptors for the Master of Science and Master of Science in Engineering programmes with those declared by each of the EES programmes; exploring several KTH policy documents and HSV reports on diversity, internationalisation, sustainability and quality assurance; and reflecting on the procedures and outcome evaluations contained in the self-evaluation reports composed by each programme.

As a result of these preparations and the extensive interviews conducted during the site visit, the sub-panel arrived at a premise for its final evaluation of the EES programmes, a calibration of its expectations upon which its recommendations could be formed. Above all, the sub-panel concluded that a strong, vibrant and competitive programme should seek to manage and harmonise the expectations and reputation of the educational programme across all its stakeholders: incoming students, current students, alumni, programme faculty, industrial partners and future employers. Focus on any single aspect alone would not ensure a harmonious relationship between the stakeholders and would likely lead to a lack of engagement among groups of stakeholders and a loss of reputation. In contrast, the sub-panel argued that a comprehensive approach should take into account:

- The interest of the programme faculty in maintaining a high level of technical content.
- The interest of incoming students in obtaining an internationally competitive degree at a reasonable cost with continued access to future employment.
- The interest of current students in building confidence and skills that stand out in a globally competitive labour market, whether in academia or industry.

- The interest of alumni in being able to proudly proclaim their continued affiliation with their alma mater throughout their career.
- The interest of industrial partners in obtaining access to the innovation and creativity inherent in the academic enterprise.
- The interest of future employers in building a recruitment base for individuals with a competitive balance between solid theoretical, technical and experimental skills, on the one hand, and skills of judgement, analysis, creativity and leadership, on the other hand.

Although the current EAE was motivated partly by the upcoming national evaluation of technology degree programmes by the HSV, the sub-panel felt that it afforded the EES programmes an opportunity to raise the awareness among its stakeholders of the great potential for success inherent in a comprehensive approach to competitiveness. In articular, the sub-panel considered the site visit interviews and the information resources mentioned above principally in the light of the concept of managing high expectations and sustaining engagement among the stakeholders.

EXAMPLES OF GOOD PRACTICE AND ASPECTS THAT ARE PARTICULARLY INNOVATIVE

As a result of the emphasis of the EAE on the process of quality assurance, the sub-panel felt that there was only limited opportunity to reflect on the technical content of the EES programmes, other than by means of the impression given through the site visit interviews, information on web pages about programmes and courses and the master's theses provided to the sub-panel by the EAE staff. On the whole, and based on these impressions, it was felt that the EES programmes had been carefully designed and provided strong technical content, in most cases supported by high-quality textbooks and learning material.

The sub-panel identified several examples of good practices and innovative aspects of the EES programmes. It was understood that the EES programmes have a strong international reputation in academia and among potential employers, and this serves to attract international students. The EES programmes were understood to be globally competitive and to have strong connections to industry, affording students opportunities to pursue course-relevant work on industry-relevant applications. The EES programme faculty and, in many cases, students were also closely integrated in collaborative research with faculties from international universities and research facilities, providing further scientific relevance to the educational programmes and opportunities for building international peer networks among researchers and students.

The EES school and programme management staff appeared to be highly engaged in ensuring the success of the EES programmes. The EES programme faculty was engaged in the teaching enterprise and, in most cases, able to integrate a strong research focus in its professional activities with course content. The sub-panel felt that existing KTH support for pedagogical training for its entire teaching faculty was a particularly innovative aspect of the educational effort and one that most programme faculty members have benefited from.

As a result, the sub-panel found the EES programme faculty committed to continuous improvement and able to make extensive use of innovative teaching tools and pedagogical approaches.

As a result of the EAE self-evaluation process, the sub-panel noted that the programme management and programme faculty were generally aware of the national qualification descriptors and the degree to which these were met by individual courses across the EES curricula. The effort to map individual course objectives (learning outcomes) to the national qualification descriptors and, in particular, to a version of these formulated by KTH to address the alignment to the 3 + 2 Bologna model, appeared to have raised awareness among EES stakeholders (faculty and staff) of the programme objectives and the added value that an EES degree would provide to its graduates.

The sub-panel felt that the programme staff and faculty understood the value in enabling further career opportunities for its students, whether domestic or international, in industry or in PhD programmes in Sweden and abroad. The programme faculty was enthusiastic about the influence it could have on the future success of its graduates and on the long-term effects on the reputation of the programme that would occur as a result. In general, the sub-panel felt that the programmes provide good opportunities for international students to step into work life, including both industry and international PhD programmes.

The sub-panel found that introduction of so-called transition seminars in the 2-year Master of Science programmes to be an innovative aspect that merited further emphasis. These seminars help students to navigate academic values and traditions at KTH as well as build a set of study and research skills that emphasise integrity, judgement and life-long learning.

For international students enrolled in the 2-year programmes, these seminars were understood to provide some degree of homogeneity across the student body, giving the programme faculty confidence that students would be adequately prepared for some of the often unspoken expectations of academic life.

Finally, the self-evaluation reports and the individual interviews identified that procedures for summative student feedback (after the conclusion of a course) are in place across the EES programmes and widely implemented in individual courses.

ASPECTS THAT REQUIRE CORRECTIVE ACTION AND ASPECTS THAT MERIT SUPPORT STRATEGIES

As mentioned above, the sub-panel concluded that a strong, vibrant and competitive programme should seek to manage and harmonise the expectations and reputation of the educational programme across all its stakeholders: incoming students, current students, alumni, programme faculty, industrial partners and future employers. A programme should:

- Maintain a high level of technical content.
- Enable access to future employment.
- Build confidence and leadership skills in its graduates.
- Provide access for industrial partners to innovation and creativity.
- Maintain continued affiliation of alumni.
- Strike a balance between knowledge, technical competence and skills of judgement.

To this end, the sub-panel recommends that all EES programmes consider adopting the following set of overall goals:

To be globally and nationally competitive, master's programmes should provide the students with knowledge about the industry and prepare them for an international career either in industry or academia, e.g. as a PhD candidate. Programme outcomes should seek to produce graduates that are competitive both in terms of technical skills and in terms of skills of creativity, transformation and the leadership required to be a globally competitive engineer. Programme outcomes should permeate the structure of curricula. The programme staff should be able to assess the degree to which students attain these outcomes across the entire curriculum. The programme faculty should also be aware of programme outcomes and be able to assess the degree to which these are attained in individual courses. The programme students should be able to reflect on the programme outcomes and the degree to which these afford a competitive advantage upon graduation. Programme outcomes and the awareness of these among stakeholders should be continuously evaluated. The programmes are to be continuously improved in both the context of learning outcomes and projection of students.

The programme faculty should create engaged learning environments that take advantage of best practices and that are aligned with innovative developments in pedagogy as well as in formative and summative assessment of course-specific learning outcomes. The programme faculty and students should conceive of KTH as an international research university and be able to draw benefits from such an international environment. They should take advantage of, and seek to grow, the diversity of programme students and the faculty and promote the development of skills of judgement and leadership enabling programme graduates to thrive in an international labour market. Programmes should actively engage with industrial partners in order to infuse knowledge of industry-relevant applications throughout curricula and in order to prepare for and enable further career opportunities in industry or in doctorate degree programmes.

In order to achieve these overall goals, the EES sub-panel has several recommendations for KTH and the EES:

Stronger focus on constructive alignment throughout the curriculum and at programme level

At present, the responsibility for developing new courses or modifying existing courses with respect to content, pedagogy or learning outcomes largely rests with the individual programme faculty. The active engagement of the programme faculty is an asset for the EES. Principles of constructive alignment within individual courses have also been shared with the programme faculty and there is a general effort to ensure that the learning outcomes, course content and assessment methods are well aligned at that level.

It is less evident that principles of constructive alignment are being applied at programme level. The sub-panel considers it as important to ensure the constructive alignment of courses (including learning outcomes, teaching methods, contents and assessment methods) at programme level. The EAE appears to be the first time that the programme faculty has been given the opportunity to assess the degree to which individual course learning outcomes address programme outcomes.

On the one hand, changes in courses may be initiated by the programme faculty without informing others involved in the teaching or coordination of the programme.

On the other hand, individual courses have to achieve learning outcomes for several distinct programmes.

While it is certainly positive that teachers are actively developing their courses, there are simultaneous challenges in assuring the constructive alignment at programme level.

The sub-panel recommends that EES programme directors collectively enable a quality assurance process that supports constructive alignment within each programme, so that individual course learning outcomes and assessment methods support the programme outcomes and enable continuous programmatic assessment. To the largest extent possible, the sub-panel recommends that programmes and, in particular, mandatory courses should be designed in a way that is, to a large degree, independent of individual instructors. Moreover, programme directors could communicate on programme structures to support the constructive alignment of programmes and courses considering learning outcomes.

At present, quality assurance at the level of individual courses is viewed as the responsibility of individual instructors and, to some degree, directors of study from the parent department or division. The sub-panel recommends that mechanisms be put in place to ensure that the quality assurance process is more of a mutual responsibility of the programme faculty and staff. For example, the sub-panel recommends that documentation and information channels be developed to ensure that the individual parts of a programme coherently support the same aim. The alignment of courses to multiple programmes requires a strong coordination among programme directors. Programme directors would benefit from sharing experiences and joining forces to develop their programmes. Moreover, there appears to be ambiguity in the perceptions of roles and responsibilities of the programme management. Clarifying the roles, responsibilities and the mandates of the programme directors is necessary.

Clearer definition of the added value of the educational programme and the competitive advantage offered to its students.
At present, the main source of pride among the programme faculty appears to be the high level of technical content and skills provided to programme graduates and their relatively high employment prospects upon graduation. However, it is lacking a clear articulation of the added value of an EES programme vis-à-vis its international competitors or even vis-à-vis other degree programmes outside of the EES. Interviews with programme students gave the sub-panel the impression that they are not always as clear on the competitive advantage, if any, that they will have in a global labour market upon graduation, and in some cases students lacked confidence in the value of the degree.

The sub-panel recommends that the EES programmes should be more clearly defined regarding how they are distinguished from other similar international programmes. This should be clearly reflected in the overall programme outcomes, derived from the national ones, but tailored to the specific programme contents and objectives. The development of such specific programme outcomes not only helps to develop specific profiles of the programme, but also allows the students to distinguish their skills, especially when compared with graduates from other comparable universities.

Students enter the EES programmes with a variety of expectations. The sub-panel observed, in some cases, a mismatch between the international students' expectations and what the EES offers them. The sub-panel recommends that the EES programmes seek to find a better match between what is expected and what is offered to the international students. A more precise profile of the programmes, based on more specific learning outcomes, might help in this perspective. Also, information about the contents of the programmes needs to be developed on the school's and the programme's web pages.

Empower the faculty, administrators and students to take a more proactive role in engaging with KTH policies, programme design, quality assurance processes and curricular innovation
The sub-panel appreciated the commitment and interest of the programme faculty in developing its teaching skills and approach. The sub-panel recommends that the EES continues to support and facilitate an atmosphere conducive to pedagogical development. Sharing good practices in teaching is beneficial not only to the individual teachers but for the creation of a strong learning environment. The sub-panel also encourages the EES to reflect on the various ways of implementing research-based education.

The teaching faculty does not often fully assimilate the various KTH policies regarding teaching, ethics, sustainable development etc. Policies, however, are a means of communicating a mutual mission, and often reflect the value basis of the institution. The sub-panel recommends that the EES programme faculty and staff reflect on the policies in relation to their activities and adopt a more proactive stance towards the implementation of the values promoted in the various KTH policies. There seems to be a certain gap in the information between KTH management and the individual faculty regarding policies and mutual missions.

The implementation of the mutual mission and code of conduct needs support and good practice examples to be fully implemented and used in the way they are intended.

Closer integration of CDIO concepts to address higher-level learning objectives emphasising judgement, insight and assessment
The CDIO (conceive, design, implement and operate real-world systems) concept has been adopted by KTH and is currently being considered by individual programmes and relevant courses. The sub-panel recommends that EES focus even more on the CDIO concept in order to emphasise students' qualifications regarding independently judging and assessing decisions during the different CDIO phases. Support should be provided to the programme faculty and staff in formulating programme objectives and course learning outcomes as well as assessment methods in a way that ensures that higher-level learning objectives can, indeed, be measured and promoted as core competencies of EES programmes.

Evaluate student satisfaction more effectively by emphasising programme outcomes and deemphasising individual course outcomes
While the procedures for summative course evaluation are well developed, students may not be actively encouraged to provide feedback during the courses. Rather, the emphasis on course evaluation is retrospective. The sub-panel recommends a more formative approach, in which students are encouraged to reflect on their course experience in relation to the learning process in the programme. This may help students to develop diverse study strategies and take responsibility for their learning. Such feedback at programme level can also be beneficial to further develop the programmes' learning outcomes.

The sub-panel recommends that the programme faculty be encouraged to share best practices. It is apparent that there are examples of well-integrated learning tools within some courses, which provide the teachers with continuous information about student learning as well as encourage students to reflect on their achievement of the intended programme and course learning outcomes.

According to the KTH internal quality policy: "Quality through continuous improvement – Quality Policy for KTH 2011–2015", course evaluation and analysis should be documented. There are varying practices as to what extent this guideline is followed among the teaching staff. There also seems to be some confusion on the evaluation process.

For example, the sub-panel was told that there are, in some cases, three different forms used: one provided by KTH, one by the instructor and one by the corresponding chapter of the student organisation. This raises questions about responsibilities related to the documentation task, the ultimate use of such documentation and the perceived utility of efforts put into the documentation. The sub-panel recommends that the functions and objectives of the course evaluations be more carefully assessed and that the teaching staff should be empowered to maximise the utility of the feedback and course evaluations. A formalised and simplified means to reduce redundancy in the evaluation process would increase the value in the feedback loop.

Feedback regarding the Master of Science in Engineering in Electrical Engineering (CELTE) programme

OVERALL STRENGTHS AND WEAKNESSES

CELTE is a strong 5-year Master of Science in Engineering programme. There are motivated teachers open to new methods and teaching approaches as well as pedagogical development. PhD students active in teaching often attend elective pedagogical courses.

Students acknowledge the very good structure of the programme's first 3 years as well as the quality of teaching during this period. Teachers active in the bachelor-level programme may not have the opportunity to be engaged in research in a similar way as their colleagues, who are mainly active in the master-level programme and seem to have a weaker focus on the quality of teaching. Master's-level teachers seem to have a more active role in research, with less emphasis on teaching.

There is a good quality assurance (QA) process with some opportunities for optimisation in order to reduce redundancies. Teachers show a strong familiarity with QA documents and processes. Course analysis has been carried out systematically. Students are very satisfied with their opportunities to give feedback to both teachers and the programme management during the course. The programme management supports the teachers in the various aspects of the QA process.

CELTE is based on standardised methods, such as CDIO, and has established a learning outcome matrix. Learning outcomes are covered by existing courses rather well. Nevertheless, there is an awareness of the fact that courses need to be revised to even better achieve their learning outcomes.

Course content and programme syllabus are reviewed every 5 years. A good coordination of courses has been achieved, in particular by informal methods among teachers.

Links to industry have been achieved by guest lecturers and visits to companies. Industrial research projects involve students in their theses. Students would like an even larger number of industrial thesis opportunities.

Bachelor degree projects are performed within a defined environment, whereas master's theses are connected to industry projects. The master's thesis provided as a sample for an independent degree report focused on the identification of commercially available products, but it lacked a significant development and/or implementation component. There is a well-defined assessment system for master's theses considering the learning outcomes.

Students are prepared to work in an international environment, e.g. by working in groups covering different cultures.

Students do not exhibit a particular interest in the learning outcomes, although these are presented at the beginning of a course. Students show a rather weak awareness of their acquired skills. They appear to lack the opportunities and skills to market themselves as globally competitive engineers.

Employability and salary perspectives have been very good in the past. Alumni job satisfaction is high.

RECOMMENDATIONS FOR THE FUTURE

A stronger focus on emphasising learning outcomes prior to and during a course might be valuable, and it may also support students in self-marketing. The programme objectives sometimes speak of "having knowledge" and "exhibiting insight", rather than "demonstrating knowledge/insight", as formulated in the national qualification descriptors. It may be valuable to consider, more specifically, how students would demonstrate knowledge so as to enable one to judge the extent to which all students meet these programme objectives.

There could be more opportunities to study abroad. This would also improve the issue of internationalisation, namely preparing students to work successfully in an international environment.

Certain QA process steps and results are not properly documented. Appropriate support from the EES might avoid additional workload for teachers.

The programme relies, to a large extent, on instructors from other schools or divisions. The self-evaluation report suggests some lack of control over the teaching offered through other schools. A greater coordination between instructors could be of significant value.

We propose that the programme be developed into what we believe is going to be a competitive advantage for KTH students in the future, such as working in a diverse environment, working in an international environment and the ability of students to market themselves in the global arena.

Feedback regarding the Master of Science in Electrophysics (TELFM) programme

OVERALL STRENGTHS AND WEAKNESSES

The TELFM programme is coordinated through a programme council, consisting of the programme director and directors of studies from the three primary divisions that manage the courses in the programme. This group is well organised and closely engaged with the quality assurance process of this programme. This structure appears to support communication between the programme director and the instructors, ensuring that there is technical coherence throughout the curriculum.

TELFM is supported by a wide range of teachers who take an interest in the programme and continuously meet and discuss the programme.

The programme emphasises technical material in its content with a significant connection to advanced research. The programme offers an innovative and unique combination of plasma physics, fusion science and electromagnetic engineering. Programme staff has extensive pedagogical experience and seems dedicated to the teaching mission.

The connection to an industrial context in this programme appears to be less developed.

The programme offers opportunities for its students to engage in an international context through thesis projects conducted abroad as well as within KTH in highly active research environments with extensive international components. For example, several research projects are part of an international collaboration that involves frequent visits from foreign researchers.

Efforts to engage further internationally have been described to some degree in the self-evaluation report and should be actively pursued.

RECOMMENDATIONS FOR THE FUTURE

During the development of this programme, there appears to have been extensive consultation between the instructors and the Programme Director in formulating programme objectives and in laying out a course structure. At this stage, however, the teachers may need to be reengaged in the quality assurance process. This includes clearly establishing the individual responsibility of instructors towards the programme, the attainment of programme objectives and the implementation of KTH-level programmatic goals and policies. This may require coordinated support from the school level and reliance on resources and support structures at KTH level.

It also appears valuable to engage the students enrolled in the programme in order to align their expectations with the objectives of the programme. More emphasis could be placed on providing the students with knowledge of the competitive edge that the students will gain vis-à-vis other international programmes. The programme could benefit from the inclusion of material addressing applications of plasma physics outside of fusion science. It is likely that this would be a better match to the expectations of a subset of the students, including those from outside KTH.

Feedback regarding the Master of Science in Electric Power Engineering (TELPM) programme

OVERALL STRENGTHS AND WEAKNESSES

The programme has a strong international reputation and so attracts good students. Students appear well qualified and mature. There is a strong technical core programme considering latest developments and technologies. The coverage of the area by the course programme is rather broad compared with other international programmes. The programme has good connections to industry and has been designed based on industry suggestions. Industry requirements are considered for theses and research. This has a further impact on teaching.

The course content and programme are reviewed periodically. There is a well-defined assessment system for master's theses aligned with the programme objectives. There are usually meetings between student representatives and course staff after each course. The results of the course evaluation are analysed and documented by the course staff. However, there is a limited opportunity for students to have an impact on the courses and the programme as a whole due to the retrospective nature of the course evaluation. Assessment methods are not well motivated in all the courses. Some students thought that some assessment methods were somewhat unfair. Some course literature does not achieve international standards in terms of periodical updates. Teachers often prefer their own lecture notes in contrast to established textbooks in the field.

The faculty is highly trained, active in research and has industry experience. Teachers have an increasing interest in new teaching methods and pedagogical development. Teachers show a good degree of flexibility. Teachers and the programme director see a need for revising the programme and courses according to the learning outcomes in the future. This should be a mutual effort. As we have understood, courses may have been modified without notifying the programme director. It is, however, essential that the programme director has an overview of developments so that constructive alignment at programme level can be maintained.

Opportunities for students to pursue working careers or certain international PhD programmes seem to be limited. Support by KTH in this perspective is modest. The programme does not meet the expectations of students to be involved in research from the beginning of the master's programme. However, alumni employability has been reported as good.

The programme director is committed and, together with the self-evaluation group, he has written a reflective report. The metrics for self-evaluation appear to be appropriately measured using the various surveys, statistics and charts mapping programme outcomes to course learning outcomes. The report points out the value in forcing a more comprehensive study of the overall programme outcomes and the way these are met by learning outcomes formulated for individual courses. The matrix presented in the self-evaluation report indicates extensive coverage of programme outcomes of a more quantitative nature in a majority of the classes and more sparse coverage of those outcomes that depend on insight, personal competence and judgement. These are skills that fall in the higher-level learning objectives category.

The learning outcomes formulated for individual courses do not necessarily align with programme outcomes. The mapping suggested by the provided matrix appears to have been developed by looking at course-specific learning outcomes, but there is no clear indication that the methodology for measuring the attainment of course-specific learning outcomes is well documented or, in a measurable way, instructor independent. Internal outcomes are not aligned with the national qualification descriptors. The faculty is not fully aware of learning outcomes and does not seem to be fully committed to and completely informed about KTH policies. There seems to be a somewhat unclear view as to what extent teachers are supposed to implement KTH policies.

In reflecting on the final degree project, it is argued that, upon the completion of the project, the student will be able to do a number of things that match a subset of the programme outcomes. It would be better to demand that these outcomes be explicitly demonstrated through the project thesis or in an accompanying oral presentation.

RECOMMENDATIONS FOR THE FUTURE

Courses and the programme as a whole should be revised based on learning outcomes.

Internship offers to students can improve the students' employability and strengthen the programme's relation to industry. International students might benefit from Swedish language courses for their future career, especially when they intend to stay in Sweden.

Feedback regarding the Master of Science in Network Services and Systems (TNSSM) programme

OVERALL STRENGTHS AND WEAKNESSES

KTH and the TNSSM programme itself have a strong reputation, which has attracted international students. By having three different tracks, the programme provides both breadth and depth. Students can select among several specialisation options within the programme.

TNSSM has a strong connection to industry and the programme directors and teachers intend to strengthen this further. The programme and its courses demonstrate a good combination of theoretical and practical elements in teaching. This is reflected by the fact that students mostly perform master's theses in an industrial environment.

A very innovative issue is that problems defined and provided by industry are used for case studies in several courses. Those case studies not only bring practical value into teaching, but also provide valuable contacts to industry. Some of the courses, e.g. Cisco networking courses, are very valuable for future employment in industry. The various courses offered in TNSSM are often based on hands-on courses such as laboratories and practical exercises, which are combined with lectures. Lab facilities are very good and permanently available to students. The courses using labs, projects and practical exercises are a valuable means to implement the CDIO approach and also to cover many of the Competence and Skills learning outcomes.

The provided sample independent degree project report confirms the impression that research and practice are well combined throughout the curriculum. The thesis report demonstrates a strong experimental research focus.

Attendance of many courses seems to require rather good programming skills, which many international students do not seem to have at the beginning of their study at KTH.

The programme appears to have little visibility in KTH's bachelor-level EE programmes, which results in a rather low number of KTH EE students in the TNSSM programme.

The employability of graduated students in both industry and academia seems to be very high.

RECOMMENDATIONS FOR THE FUTURE

We encourage the programme staff to take an active stance towards promoting the attractiveness of computer networks, especially in KTH's EE programmes at bachelor level.

Student recruitment seems to be based on a rather small set of information and criteria. More flexible selection criteria might be desirable, e.g. students' research interests, which may also help to attract students whose interests are in line with the profile of the programme.

Efforts are needed to ensure that the students have appropriate programming skills in order to successfully follow the courses. This could be achieved by a special course prior to or in the 1st semester.

While TNSSM has, so far, been a single-track programme, teachers have had a holistic view of the programme. With the introduction of the various tracks, the need for some level of formalisation is likely to emerge, including documentation and communication in order for all teachers to be aware of programme-related procedures. Simultaneously, due to the new three-track system, there is a need to align the programme with the bachelor-level programmes. Systematisation and documentation may also serve the purpose of assuring the alignment of the different level programmes so that they form a coherent whole.

Feedback regarding the Master of Science in Systems, Control and Robotics (TSCRM) programme

OVERALL STRENGTHS AND WEAKNESSES

The TSCRM programme has a strong technical focus, a strong international reputation and is believed to provide students with a competitive edge upon graduation. Anecdotal evidence suggests that international employers appreciate the value of a KTH education in general and the system control and robotics programme in particular.

The TSCRM self-evaluation group has provided an interesting set of observations, given the limited amount of student data. Much of what has transpired since the inception of this programme appears somewhat ad hoc, however, and largely driven by interactions between students and the programme director, who has clearly been an integral member of the overall education programme. It is also clear that the programme, in many cases, relies on service courses offered by other departments/divisions, and thus the programme director feels little control over the competence profile of individual instructors, the teaching paradigms employed by these instructors or the degree to which the instructors align assignments and learning outcomes with the programme outcomes. This lack of accountability permeates through much of the report

and does not reflect that well on the overall organisation.

In charting a way forward, the report identifies the need for a programme council to offer more continuous quality assurance. A number of ideas are offered for how to improve the student experience.

The programme targets, as its customer basis, students and employers within academia as well as industry within Sweden and throughout the world. Some effort is currently made in providing opportunities for students of different nationalities to collaborate in learning and to experience diverse points of view.

A challenge to a well-functioning quality assurance process is the limited ability of the programme and its students to influence which elective courses are offered within the context of the programme. This is due to the small fraction of students from this programme in each course and the focus of the instructors on the technical content within individual courses rather than at programme level.

The instructors are, in many cases, highly educated in pedagogy and willing to be engaged in a process of continuous improvement. This should be encouraged and supported.

RECOMMENDATIONS FOR THE FUTURE

It appears to be important that the structure, organisation and programme content be more clearly defined to instructors and students and that all aspects of the programme reflect a clear drive towards the goals set out in the programme outcomes and the KTH 2011–2015 Quality Policy, particularly in the areas of leadership and competitiveness.

The programme would appear to be attractive due to its breadth and the unique combination of control and robotics. Some courses offer extensive opportunities for industry contact. It is strongly recommended that this be further integrated into the curriculum, since it likely matches a significant portion of the student body.

We strongly recommend that students are engaged at all levels of the quality assurance process in order to better align their expectations with the programme outcomes, and vice versa.

Feedback regarding the Master of Science in Wireless Systems (TTLSM) programme

OVERALL STRENGTHS AND WEAKNESSES

The TTLSM programme aims to train students for later careers in both industry and academia. The programme includes a well-defined set of three tracks. The programme defines a strong profile for their graduates. Top-level students are supported by so-called accelerator courses.

Changes in courses, which are shared with other programmes, might not have been communicated to the programme director, although these changes have an impact on the programme.

The programme is flexible in accepting permanent feedback from students. Students appreciate good learning material and a fair examination. Students seem to have a single point of contact for the whole programme, which serves as a single entry point for all three tracks of the programme.

While the faculty considers the courses to provide a good mix of theoretical and practical content, students perceive the curriculum, and in particular the 1st year, as too theoretical. Practical elements are rather focused on simulation, while there seems to be less focus on real system development and operation in the various courses. The experimental focus of courses is rather limited. Students might appreciate more system-oriented courses. This, however, would require the students to acquire better software development and programming skills. However, the sample independent degree report shows a strong combination of both theoretical investigations and experimental research. The programme objectives defined by the programme follow the national learning outcomes for Master of Arts/Science (120 ECTS).

Teachers have a strong research focus in general. This is reflected in certain courses in which students are trained to perform independent research work. Excellent student research works performed in (heterogeneous) groups are awarded by the programme, e.g. by giving the students the opportunity to have their work published.

Students have the opportunity to perform scientific group work quite early on in the programme. The teachers' commitment to the students is reflected in their being available to the students and proactively making efforts to support the students, e.g. in laboratory work. Students are also very flexible regarding their theses. Students have the choice to do their thesis work at KTH, another university or in a business setting.

Links to industry are established by seminars and invited lectures. Students have the opportunity to establish industry contacts via the faculty. Nevertheless, students would be interested in improved collaboration opportunities with industry. Given the strong industry presence in wireless communications around KTH, this is an opportunity to be exploited further in the interest of the students.

Alumni report that they are satisfied with scientific and technical skills, but there is room for improvement regarding non-technical skills. Employability of students seems to be rather high.

RECOMMENDATIONS FOR THE FUTURE

Mechanisms for programme coordination and development should be improved so that the programme director is always aware of any course modifications.

Since some international students have difficulties getting summer internships, more support from the school or even support at KTH level should be provided.

More system-oriented research is desirable. This requires providing students with appropriate software and programming skills.

Feedback to KTH management

KTH should clearly communicate what international students can expect in the international master's programmes in order to avoid unrealistic or non-coherent student expectations.

KTH should market individual programmes and put forward their individual strengths and weaknesses, rather than just marketing KTH.

Support to students in finding accommodation and industry internship positions would be appreciated by international students. Internships and integration with industry would also benefit Swedish students as well.

KTH should ensure that KTH policies are communicated to the faculty and students in a way as to encourage commitment and involvement in a mutual agenda. Also, providing support and encouraging good practice examples should be shared.

Teachers should be supported in methods to integrate issues of diversity, internationalisation and sustainability into their courses. This could be done by dedicated courses, workshops or seminars, similar to pedagogical courses for a young faculty.

In general, however, programme and course development is the responsibility of the schools and their programmes. KTH should provide sufficient resources and an environment where school and programme directors, as well as teachers, can perform their work efficiently.

Students might benefit from Swedish language courses for their future career, especially when they intend to stay in Sweden. Appropriate language courses could be offered to students of the international master's programmes.

Feedback regarding the EAE methodology

The sub-panel had the impression that programmes had too little time to prepare the documents. Considering the time, however, quality of the self-evaluation reports has been good.

There is a mismatch of learning outcomes for the evaluation and the individual programmes' learning outcomes.

To achieve an even more effective evaluation process, one additional step, prior to the site visit, might be helpful. In that case, schools and programmes could be explicitly provided with questions, and answers to those questions could be prepared by schools and programmes for the interviews.

Material (evaluation criteria, objectives) could have been provided to students to support their interview preparations.

It would have been appreciated if more Swedish students with specialisation in the assessed master's programmes could have been available for the interviews.

Single sample individual degree project reports are not representative and might give a distorted picture of the quality of a school. More theses could be provided as a basis for the evaluation.

Evaluations might consider programme content and their philosophy in more detail.

Self-evaluations could focus more on objectives, intended products and visions.

Information and Communication Technology (ICT) Sub-panel report

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Erik Bruun, Technical University of Denmark
Monica Divitini, Norweigan University of Science and Technology
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Agnes Kåregård, Uppsala University (student representative)
Fiona Martland, Engineering Professors' Council
Michael Williams, Ericsson

First of all, the sub-panel members would like to thank KTH for inviting us to come to KTH and assess the bachelor's and master's programmes offered by its School of Information and Communication Technology at Kista.

Feedback to the self-evaluation groups and school management

Two days of stimulating discussions with the members of the ICT staff gave us the impression of a highly motivated teaching staff willing to provide education at the highest level. Also, the high-profile research environment created by Kista staff forms an excellent setting for good teaching and internationally recognised programmes.

The new CINTE programme finally seems to have got a sufficiently large number of first-hand applicants. After a decade of high dropout rates, possibly because of having accepted students with qualifications that were too low and students whose motivation levels were too low for advanced studies, we got the impression that the programme has had a restart.

The most obvious aspect requiring corrective action is the large dropout rate over the past decade. Judging by the footprint diagrams, these numbers appear to have been far too high. Also, the programmes in Microelectronics, Photonics and Nanotechnology should be cancelled because of the low number of students. On the other hand, there is now a unique opportunity for KTH to reformulate these programmes and to come up with a timely programme offering transparent education, from systems level to microelectronic hardware and technology.

Also, the organisation of the teaching staff for the 3-year B. Eng (högskoleingenjör) programmes should be reconsidered, and efforts made to reinforce the status of this more engineering-oriented staff that do not always fit naturally into the research organisation in place. See also recommendations to KTH management.

Feedback regarding the Master of Science in Engineering in Information and Communication Technology (CINTE) programme

STRENGTHS

Without having seen the curriculum in detail we got the impression of a modern, well-organised programme where students learn how to learn in a rapidly changing environment. The programme has had a high dropout rate, but recently the number of applicants has increased. This will probably result in an increased motivation, which will improve the dropout figures. The interviewed students were very enthusiastic about the programme and their chances of finding employment in this field.

The programme management was pleased with the new situation for this programme. Obviously, they were aiming for a new start to the programme, not letting the previously high dropout rates prevent them from going forwards.

Management seemed to have a clear view of the programme and its 3 + 2 organisation. The involvement with industry is good, especially at master's level. The students seem to have good opportunities to influence the programme and its courses through evaluations and through direct contact with the staff. The interviewed teachers were enthusiastic and had a strong interest in making the bachelor and master's level well connected. Overall, the attached master's theses reports were of a high quality.

WEAKNESSES

In previous years the programme has had too high dropout rates and too low production. One reason seems to be that students are getting job offers from local companies before graduation, a good sign for employability but not a good sign for the programme or for the students when viewed from a long-term perspective.

Even though the programme leaders had a clear view on the advanced level of the 5-year programme and the related master's programmes, KTH is, in general, not very convincing in explaining the advantage of offering 5-year integrated "civilingenjör" programmes in parallel with 3-year bachelor programmes and 2-year master's programmes. The fact that the names of the "Informationsteknik" and "Datateknik" programmes at KTH correspond to "Datateknik" and "Informationsteknik" programmes, respectively, at other schools in Sweden may be an information problem when recruiting new students.

RECOMMENDATIONS FOR THE FUTURE

- Find strategies for maintaining or even increasing the number of first-hand applicants and reducing early dropouts.
- Continuous investigations on how to improve study results.
- Encourage students with job offers to graduate first. Initiate discussions with local companies on this topic.
- Include industry-related courses or projects at bachelor level to motivate the campus location to Kista.
- Clarify the structure of 5-year programmes in parallel with 3-year bachelor programmes and 2-year master's programmes at both ICT school level and KTH level. Discuss the possibility of only using the 3 + 2 structure.

Feedback regarding the Master of Science in Communication Systems (TCOMM) programme

STRENGTHS

The programme seems to be consistent and well organised. Without having the opportunity to study the curriculum in detail, the programme management tried to give us a picture of a programme where its courses were designed to fit together to form a programme with student progression. Updating the courses is a continuous process for being up to date and in pace with this rapidly evolving field. There is a continuous dialogue with industry for deciding which courses should go into the programme and for updating the course content.

All courses include both theoretical and practical parts, and at the overall level the programme seems to offer courses adopting a good mix of learning activities and appropriate assessment methods. The programme management wants to implement the CDIO concept in the programme as a whole. This is, however, a process that takes time, and the programme management cannot really influence teachers and course content. The programme management is encouraging all the teachers to take the pedagogical course, and the majority of the teachers have had pedagogical training. Projects and project courses make up quite a big part of the programme, and this is very much appreciated by the students. Sustainability is somewhat included, at least in the big project course in the 3rd semester. There are a fair amount of guest lecturers from industry.

Teachers and students actively participate in the evaluation of the courses. Course analysis is based on students' feedback and interviews with the Course Board.

WEAKNESSES

To the panel it was confusing that the programme management considered the programme an international programme with international students only. We believe that the KTH bachelors and the international students should be integrated and that the programme management should embrace all of its students equally. However, as will be explained elsewhere, this is mainly a consequence of a weak programme structure as defined at the KTH President level.

The position of programme director is only approximately 10–15 %, i.e. 4–6 hours per week, which is not enough hours to cover for the daily requirements to do with teacher, student and industry contacts. We recommend that the programme director position should be strengthened.

Another observation made by the panel is that all four mandatory courses during the 1st semester are taught by the two programme directors, in addition, one of them only on a junior time-limited position. While they probably do an excellent job, it gives a strange impression that full professors engaged in research are not visible during this first term.

It seemed to the panel that a number of master's theses were too focused on investigations and lacked the design phase. However, the programme management declared that this was not the case, but that they should contain a design phase. One strength of the programme is that for each master's thesis the literature search and the part of the thesis relating the project to the state-of-the art is assessed separately.

RECOMMENDATIONS FOR THE FUTURE

- The tuition fee is a threat to the TCOMM programme, which has experienced a large decline in the number of applicants this year. If the 3 + 2 educational structure was fully implemented at KTH and there would be no separation between the international students and the Swedish students, the programme would probably be less dependent on paying students. Integration among different student groups would be beneficial for all students.
- Increase the involvement in the programme of full professors engaged in research during the 1st semester.
- Continue working on the implementation of CDIO.

Feedback regarding the Master of Science in Embedded Systems (TEBSM) and the Master of Science in System-on-Chip Design (TSKKM) programmes

It is noted that the TSKKM System-on-Chip programme has been in existence for more than 10 years, whereas the new TEBSM Embedded Systems programme has its first student intake in 2011.

STRENGTHS

- The TSKKM programme is a well-known programme which, for many years, has attracted many international students. The TEBSM programme also, the first time it is offered, has already had many applicants.
- The TSKKM programme is very well perceived by the students interviewed by the panel. Apparently, the transition from a university in another country to KTH and the KTH way of teaching has been designed in a smooth way, although there were comments that written examinations only seven weeks into the programme were a challenge.
- Both programmes are led by very enthusiastic programme managers.
- The programmes comprise a good blend of theory and practice in the form of hands-on lab exercises.
- The programmes also have strong links to research and industry in the field.
- Routines for updating the programmes seem to work in practice, although the formal routines for this could be improved.

WEAKNESSES

- Few Swedish students follow the programmes. In this context, the location at Kista campus is seen as the main problem in this context.
- Cooperation with (and student recruitment from) computer science and electrical engineering, which are located in Stockholm, is difficult because of the location at Kista.
- Some concerns are expressed about overlap between the two programmes, leading to a discussion of whether they should be merged into one programme. Apparently, students in the TSKKM programme can specialise in embedded systems, which creates some confusion in relation to the TEBSM programme.

RECOMMENDATIONS FOR THE FUTURE

- A merger of the two programmes has been suggested by the school management, with the TEBSM as the continuing programme with a system-on-chip specialisation. This is an obvious proposal and, due to our different backgrounds, the panel did not immediately agree on whether this would be a timely decision or not. It was pointed out that although SoC might be considered a specialisation of embedded systems, the brand name and the international recognition of the TSKKM programme is important and should be nurtured. Obviously, both programmes attract a good number of international students today. The TSKKM programme contains courses and topics in electronic circuit design (e.g. analogue electronics) which attract students who want to pursue this line of study, which is rather different from embedded systems. On the other hand, embedded systems could attract students with a strong background in computer engineering who would probably have a different focus from SoC students.
- In short, the panel does not see this as an imminent decision. Rather, the TSKKM programme could be modified and its embedded systems' specialisation removed. The marketing of the two programmes could be arranged to attract students with different backgrounds and interests.
- The self-evaluation report points to the introduction of formal routines for monitoring programme quality. This suggestion can be supported although the site visit and interview, with the programme management, teachers and students giving the impression of well-designed, high-quality programmes.
- The issue of campus location should be addressed, especially if more Swedish students are to select these programmes.
- A transition to a 3 + 2 Bologna model may make it easier to market the programmes towards Swedish students, as the programmes have an individual identity, rather than being contained as specialisations in 5-year programmes.

Feedback regarding the Master of Science in Software Engineering of Distributed Systems (TSEDM) programme

Overall, this is a truly excellent programme with a relevant and well-coordinated content run by enthusiastic staff. Students are highly employable. Although there has been a considerable reduction of applicants due to the introduction of tuition fees, the programme has succeeded in attracting an acceptable number of students. This programme should be seen as "best practice" and give inspiration to other programmes.

STRENGTHS

The programme combines distributed systems and software engineering. This combination is rather unique and it meets a need in industry. The high level of cooperation among the core teachers involved in the programme ensures a coherent educational offer within the programme. Teachers are highly committed to provide and keep a creative teaching and research environment. They are well aware of the challenges connected to teaching in a highly dynamic context with rapidly changing knowledge and needs. The courses reflect this awareness, focusing more on learning core concepts and general practices rather than developing competencies in specific languages or techniques that can quickly become obsolete. They try to make courses as independent and self-contained as possible. This seems to be appreciated by students. Students do not see a small repetition of content as a problem if it helps them to look at some concepts from a new perspective of contextualising the knowledge to the course content. Mandatory courses follow the ACM recommendations, while elective courses are more related to research.

Having the teaching staff doing research in the areas covered in the programme at a high level ensures that the course content is up to date and challenging for the students. The programme seems to combine both theoretical and practical learning activities in a satisfactory way.

Looking at employability, it seems that the programme has succeeded in providing an education relevant to students who want to start a job in industry after graduation (approx. 70%) as well as to those who want to continue with PhD studies.

Courses are continuously analysed by the teachers and at programme level, although students are sometimes not available to provide feedback.

WEAKNESSES

While the programme has a good level of industry contact, especially with large companies, there is room of improvement when it comes to contact with small to medium-sized enterprises (SMEs). However, since this also seems to be a challenge for other programmes, industrial involvement could be addressed more systematically at school level.

RECOMMENDATIONS FOR THE FUTURE

In the near future, we know that a huge number of high-volume products will emerge in the embedded systems area. Ericsson, for example, has a slogan: "50 billion connected devices". It is well known that the volume of software in these products will be very large – often millions of lines of source code. Engineers developing products in this field require knowledge of both hardware and software development as well as networking.

There is a great opportunity to combine the discontinued microelectronics programme with the emerging embedded systems programmes. In many cases, products start life utilising more conventional computer hardware which is rationalised to System-on-Chip (SoC) later; separating an Embedded Systems programme from a SoC programme would thus be very unfortunate.

Feedback regarding the Bachelor of Science in Engineering in Computer Engineering (TIDAB) and the Bachelor of Science in Engineering in Electronics and Computer Engineering (TIEDB) programmes

STRENGTHS

These 3-year engineering programmes are recognised as good programmes, and their graduates are in great demand in industry. Students we talked to were enthusiastic and found employment in Sweden easily. However, the "högskoleingenjör" (HI) programmes do not seem to fit in with other KTH programmes, and this needs attention. KTH needs to focus on quality rather than quantity with regard to HI programmes. More regular and formalised contact with Swedish industry is needed. This is mostly an issue for KTH central management.

The main objective of the HI programmes at KTH is to provide employable and suitably educated engineers for Swedish industry at bachelor level. Providing candidates for master's studies or PhD candidates is less important than for other programmes. This is in sharp contrast to other programmes at bachelor level and the civilingenjör programmes, which aim to provide engineers at a higher level of education.

This makes the HI programmes an "odd bird" amongst the other KTH programmes, causing problems with regard to the status of the teachers, the connection to research work etc. For example, there is often no real need for a teacher in a HI programme to have a PhD.

Sweden is in great need of engineers at "högskoleingenjör" level, and KTH's role in providing them needs to be discussed. One solution could be for KTH to stop this level of education and hand it over to other universities. However, the KTH "brand" is seen as being very important to students, many of whom would probably not have chosen this type of education at another university. KTH needs to take its HI programmes more seriously and ensure that this qualification has the status and attention it deserves and is indeed required by Swedish industry.

WEAKNESSES

The present HI programmes have a high dropout rate, i.e. a high rate of students not completing their studies. Students we talked to attributed this to two things: entering this level of education and not realising the difficulty level of these studies and low entry requirements. KTH needs to put more emphasis on quality in the recruitment of students in this area and less on quantity. Unfortunately, KTH is paid per successful student, so this puts pressure on quantity rather than quality and endangers standards.

The TIDAB and TIEDB programmes seem to have little feedback from industry and have not been compared to similar courses with other universities. A more formalised and better contact with Swedish industry would be highly desirable. KTH need a forum to discuss how to create good courses of this type. Students we talked to would like to have move opportunities than are available today to specialise during their 3rd year.

RECOMMENDATIONS FOR THE FUTURE

- KTH central management needs to reinforce its support to HI programmes. It needs to make a statement to this effect and also take other actions demonstrating its support.
- The status and necessary qualifications of the teaching staff needs to be addressed.
- More contact with industry with regard to the content of these courses is needed.

Feedback regarding the Master of Science in Engineering in Microelectronics (CMIEL), the Master of Science in Nanotechnology (TNTEM) and the Master of Science in Photonics (TPHSM) programmes

It was not clear at the time of this assessment how these programmes will evolve. Nor was it clear what process will be put in place to improve the situation. Neither the panel nor the staff found much meaning in assessing cancelled programmes in any detail. Some observations we made tend to point in the direction that the approach to CDIO was not line with the intentions of KTH management. Also, the panel observed that pedagogical background of the teaching staff was too weak in terms of pedagogical courses. One obvious strength of the Photonics programme was the Erasmus Mundus exchange programme, giving an insight into other forms of examination of, for instance, master's theses reports.

RECOMMENDATIONS FOR THE FUTURE

At this point there seems to be a great opportunity for a new cross-disciplinary programme, combining an embedded system, software development and microelectronics. Today, we do not know what products will dominate the market 5 years from now, but we do know that many more products will emerge in the embedded systems area. These systems will need both new hardware and software, which must be designed and developed in close cooperation with each other. Hopefully, the emerging Embedded Systems programme will meet this need. Note that this is not only a System-on-Chip issue, it is about embedded systems in general.

Feedback regarding the Bachelor of Science in Information and Communication Technology (TKOMK) programme

We recommend that this programme be cancelled. It has poor student recruitment and does not really fill any needs that cannot otherwise be filled in the existing educational structure.

Feedback to KTH management

The most obvious issue to bring up first is the 3 + 2 issue. The presentation of the KTH educational structure on the first day was very confusing to the panel. Maybe a presentation in Swedish with "civilingenjör" programmes, "högskoleingenjör" programmes and international master's programmes would have been more straightforward and less confusing, were it not for the extra TKOMK bachelor programme and the odd 1-year master's programmes. But at the same time, KTH management claims that KTH has adopted the 3 + 2 Bologna structure, which the panel found was not really the case. We believe that the time has come for KTH to fully adopt the Bologna 3 + 2 structure, then there would be only two 3-year bachelor tracks: the Bachelor of Science (BSc) track and the Bachelor of Engineering (BEng) track. The BSc opens up the road to the Master of Science specialisations, while the BEng is a final engineering degree. Certain accredited combinations of BSc and MSC programmes could still result in a civilingenjör degree.

One important matter to bring up on this topic is the integration of the Swedish and the international students in the master's programmes. When we talked to the master's programme managers about their students, we gradually found out that they were only referring to the international students. The civilingenjör students taking the same master's programme as their specialisations were not integrated. We believe that such a differentiation should not be made, but that the two groups of students should be integrated into one class. This has been done at other universities. The responsibility for all the master's students in a certain master's programme should be given to the management of the same master's programme. Such a responsibility could easily be delegated to them by the civilingenjör programme management, which would then have two main duties: the full responsibility of the curriculum and assessment of the first 3 years of the BSc programmes and the responsibility to work together with the master's programmes to oversee that the goals of the civilingenjör degree are fulfilled. It is desirable that the Swedish Universities like Chalmers, Linköping and Lund work together with KTH on this matter.

The second issue to bring up concerns the status of the 3-year BEng (högskoleingenjör) programmes and their teaching staff. Here, KTH central management needs to reinforce its support for these programmes. It needs to make a statement to this effect, and also take other actions demonstrating its support. The status and necessary qualifications of the teaching staff needs to be addressed. The main objective of the KTH "högskoleingenjör" programmes is to provide employable and suitably educated engineers for Swedish industry at bachelor level, while to a lesser extent the objective is to provide candidates for master's or PhD studies. This is in sharp contrast to other programmes at bachelor level and the civilingenjör programmes which aim to provide engineers at a higher level of education. This makes the "högskoleingenjör" programmes an "odd bird" amongst the other programmes at KTH, causing problems with regard to the status of the teachers, the connection to research work etc. For example, there is often no real need for a teacher in a "högskoleingenjör" programme to have a PhD.

Regarding specific programmes, the panel believe that the

TKOMK programme should be cancelled. The recruitment to this programme has not been overwhelming and there are already access programmes ("tekniskt basår") available for students with various non-technical backgrounds. We applaud the recently started Embedded Systems programme and hope that it will attract a large number of students by offering an education containing not only hardware aspects but also software aspects. Regarding the Microelectronics, Photonics and Nanotechnology programmes, one of them already being cancelled and the other two are possibly on the edge of being cancelled, the panel believe that KTH now should use this strategic moment to come up with a visionary and forward-looking programme in the microelectronics field while not neglecting the ever-more important systems perspective.

Regarding CDIO, the panel believes that KTH management should clarify its intentions. Is CDIO a myth or a reality, or does it matter? The attitude of the staff towards CDIO is varied, but there is definitely no general buy-in of CDIO. Does CDIO help or is it just a political necessity? Interestingly enough, it seems that the TIDAB and TIEDB programmes seem to take CDIO more seriously than other programmes.

Regarding the assessment of master's theses, there could be an issue to reconsider that at KTH the same person can be both supervisor and examiner. At some universities these two positions must beheld by different people. In the UK and Ireland, as in DTU and NTNU, they even employ external examiners to come in and examine and assess the thesis reports.

Finally, this report would not be complete without bringing up the issue of Kista campus, as this issue was brought up repeatedly during our time at KTH. First of all, let us point out the fact that the panel does not have the solution to this intricate and controversial issue. We understand that KTH has invested a lot of money to build an internationally recognised world-class research environment at Kista campus. Also, Kista campus is located right in the middle of one of the most important ICT clusters in the world, with multinational companies such as Ericsson, IBM, Sun, Tele2, TietoEnator and Nokia. However, when it comes to education, KTH has not exploited the advantages of Kista campus. Instead, all kinds of problems are continuously hampering the development of the educational programmes. Similar programmes are offered at two campuses, from a systems perspective, ever-more important cross-disciplinary interaction between the EES, CSC and ICT schools are hindered because of the two campuses. The ICT programmes have low application rates because of the location of Kista campus, and student mobility between EES, CSC and ICT master's programmes is low because of the commuting problem between the two campuses.

The panel believes that KTH management must work harder to exploit the advantages of some programmes being located at Kista campus. The panel's preferred option would be for a real commitment to developing a different kind of engineering education at Kista, stressing the close links with industry. This will need some investment, for instance, we believe it will need a suitably staffed Industrial Liaison Office which can develop links with companies and also advise students and help them to find summer placements etc. It could also develop links to help with project work, visiting lecturers and mentors. For instance, using this approach, it might be possible to use some problem-based learning from the first day of the programmes offered at Kista.

The panel also believes that there could be some benefits in setting up an Industrial Advisory Board for ICT. This group could look at ways of fostering good links between companies and the staff and also act as a sounding board for both course and programme updating and the development of new courses and programmes. Finally, the panel believe that KTH will need to help to develop some sort of student life in Kista so that students do not feel cut off from life in Stockholm.

Feedback regarding the EAE methodology

This has been a very stimulating assessment exercise for the panel to take part in, and a number of important conclusions can be drawn. First, it is an interesting top-down approach trying to assess the quality of the educational programmes by looking at the programmes from a process perspective: what processes are in place for assessing that students meet the intended learning outcome (ILOS) and what processes are there to check whether these learning outcomes meet the learning outcomes at the next higher level? Programme ILOS should be mapped onto the course-level ILOS, and so on.

Also, this idea that the quality of a programme, and whether its achieved learning outcomes (ALOS) meet its ILOS, could be evaluated through the master's thesis reports could be discussed. The panel found it somewhat difficult to do this without having seen the curricula and without having seen a more detailed list of the teaching staff and its qualification. The exercise did not take into account syllabuses for programmes, content of courses etc. Although it would not have been possible to look into this in detail, leaving it out completely was unfortunate and degrades from the quality of the exercise.

Therefore, we believe that the whole organisation of the self-evaluation should be reconsidered before the evaluation planned for 2012 by the Swedish National Agency for Higher Education (Högskoleverket).

We assume that we can be frank, saying that the self-evaluation reports were boring to read and probably boring to write.

In this, its first revision, too much of the identical information was repeated in the self-evaluation reports of each programme. Dropout and examination data could have been presented in a more consistent way (some data was presented in tables and some as footprint notes) across each school, and probably across KTH too. The panel appreciated the common self-evaluation report by the Microelectronic programme and two of its master's programmes.

Also, a comment on topic 4: "Describe the processes for reviewing course content and programme syllabus". The response to this question could, preferably, have been presented at in a folder, covering the joint school level. If there is a system across a school, or even across KTH, with a Quality Committee at school level, a review committee at programme level, student feedback through course evaluation forms and meetings at course level and periodic (occasional) feedback from industry, each programme need not repeat this in its self-evaluation report. Having this information in a joint school folder, it would have been more relevant then to ask about the experiences for each programme in relation to these processes.

Another comment might be that if a number of general questions are asked about processes you will probably also get a number of general answers, most often coinciding with the official policy that could be read anywhere on KTH's websites. Hence, the panel was not immediately much wiser from reading the self-evaluation reports. Fortunately, there was some interesting programme-specific information here and there among the official doctrines.

The panel, of course, already knew that KTH is a top-ranked technical university in Sweden. An interesting question that was asked to the panel members by its Chairman before the meeting at KTH was whether this is a conclusion that can be drawn from reading the self-evaluation reports. However, unfortunately there were never any answers to this question.

The panel also have some objections to meeting the same people in different roles: first as programme managers and then as teachers. During interviews with teachers active in the programme we would also like other teachers than those involved in the self-evaluation to be included.

The panel also believes that there was a lot of focus on structured/top-down methods for quality assurance, but too little on creating the opportunity of sharing knowledge and best practice among teachers. The panel is afraid that KTH is going towards a dangerous path of disempowerment with a top-down quality assurance approach that is seen as the panacea to all KTH's problems.

Perhaps this top-down approach is the reason that the EAE paid so little attention to the content, syllabuses and relevance of the courses to industry? Even though the panel members are keen on Quality Assurance, they would want a version which encompassed course content, syllabuses and the relevance of the courses to industry. Indeed, that is why the panel would be keen to see a strong Industrial Advisory Board closely cooperating with KTH to define and support competitive and attractive courses and programmes.

Industrial Engineering and Management (ITM) Sub-panel report

Carl Johan Fogelholm (Chairperson), Aalto University
Martine Cazier, Ecole Centrale Paris
Kalevi Ekman, Aalto University
Kas Hemmes, Delft University of Technology
Ann Segerborg-Fick, Scania
Tim Torvatn, Norweigan University of Science and Technology
Martin Västermark, Uppsala University (student representative)

Feedback to the self-evaluation groups and school management

EXECUTIVE SUMMARY

KTH is known as one of the best-ranked universities in the Nordic countries. All well run organisations are continuously improving their working methods. The fact that KTH has initiated this EAE project clearly indicates that KTH is well aware of the fact that it must continuously improve the organisation, the teaching methods, learning outcomes and discussions with its stakeholders.

The first part of the ITM programme evaluation, based on self-evaluation reports, raised much discussion in the evaluation team. The number of programmes and the amount of information was large, and quite a lot of time was needed to build a common understanding and to agree on key findings that should be discussed further at the site visit interviews. The overall impression was that the reports were somewhat heterogeneous, reflecting the heterogeneous organisation of quite different educational programmes in one school (ITM). Therefore, the panel was unable to give a well-founded review on the various curricula and their exact content, structure and level. A more detailed description of the programme's content and the teaching staff's cvs would have helped to assess the quality of the programmes when split up in more homogenous groups for different panels. For example, four (random) samples of a final thesis were provided, and the team made some slightly negative remarks on their quality. However, we were unable to further explore this topic at the site visit interviews because only in one case were the participants familiar with the particular final thesis. Our recommendation would be to provide more examples of theses in English, as well as their grading, to the panel.

Our conclusion is that the number of programmes offered seems to be too large to achieve good external visibility, and in some cases will lead to overlap within the ITM School and probably with other schools' programmes as well. As a result, we found ourselves focusing more on organisation and management issues.

The second part of the ITM programme evaluation was executed in the form of site visit interviews. We heard that a lot of work was put on the self-evaluation part. Positive comments were addressed to increased cooperation and better access of KTH statistics. Our overall impression at the meetings with the students and teachers was positive, also providing evidence that continuous improvement and course-level quality control work was being practised. We were surprised that the site visit did not include any excursions or case descriptions about creative solutions, learning environments or applications on modern pedagogy. The organisation did appear quite centralised and self-centred, quite unused to sharing best practices, systematic benchmarking and input from stakeholders. A need for a more fluid communication process within KTH and with all external stakeholders, as well as a stronger recognition process of teaching achievements, was evident in nearly all of the meetings.

Based on the reports and discussion, a lot of effort has been made to define the learning outcomes. However, our impression was that those descriptions were directly following the national qualification descriptors. Second, we did not see much evidence or explanations of how the learning outcomes have been achieved. The samples of thesis work did not give much evidence of that. On the other hand, the discussions with (selected) ITM students gave indirect evidence that some of the most important learning outcomes are well achieved. An improved focus, with each student achieving the learning outcomes (and to which degree) would probably help to improve the programmes where needed. It would also demonstrate to each student why they should continue to progress until graduation, thus supporting student retention and alumni pride in their university, school and programme. There must be a constant awareness that there is a difference between the implementation of the learning outcomes in the programmes and the actual student achievement. A checklist is not an appropriate evaluation tool for either of them.

Finally, actual students and staff internationalisation, as well as holistic sustainability knowledge were absent from most of the programmes.

The panel's recommendation is to strengthen at each level (KTH, School, programmes) the processes to support internationalisation and sustainability, as a two-fold key strategic focus of KTH: mobility to become an asset for each student and teacher and sustainability embedded in the core of the programmes.

In short: "open up" your organisation, in "time and space" to society at large and to a long-term perspective. You have started to do so by inviting us and we wish you an interesting and rewarding "journey". It has been our pleasure to support you, and along the way we have learned a lot to improve our own organisations.

QUALITY ASSURANCE PROCEDURES

We have a feeling that there is a good interaction between teachers, teachers and students and students and programme managers. The students seem to be well involved in the quality process.

When it comes to the self-evaluation process in particular, but also quality assurance in general, the panel is of the opinion that the ITM School could have been better at involving external stakeholders. We hear a lot about the importance of involving stakeholders, but rather less about successful examples, and the general impression is that the school is somewhat inward-looking and self-centred when it comes to evaluating what they are doing. This EAE exercise is, however, a good example of how external parties can be involved in the quality assurance process. Evaluating processes similar to this one in scope, but more limited in scale, should be run more often, in relation to single programmes, as well as in relation to the school as a whole.

The most important stakeholder, from the perspective of KTH, is the industry. Successful references to involvement with external stakeholders is most often presented in relation to industry. However, while they seemed to be involved to some extent in the teaching, particularly when it comes to guest lecturers and presenting students with "real-life" problems which can be used in projects and thesis work, they seem less involved in quality assurance procedures and management. For example, when the CENMI programme was presented, we got the impression that industry was involved rather late in the process, after the main components in the programme had been decided. External reference groups and board memberships by industrial representatives could perhaps have been used more extensively and systematically, particularly for the more strategic educational initiatives.

While there is a willingness to involve industrial representatives in the strategic plans of the school and its programmes, other potential stakeholders seem even less involved. External stakeholders such as governments, research institutions and other educational institutions seem to be involved only to a very small extent. Moreover, KTH and their engineers are part of society at large, so ways should be found to involve society with a diverse range of stakeholders, such as governmental organisations, municipalities, social movements, public opinion etc. This also strongly relates to issues such as ethics and sustainability. In particular, we would recommend that other educational institutions are used more frequently as collaborators and for benchmarking purposes of different sides of the school and programme-level decisions. It is often better to have a lot of small projects involving a few types of decisions than large and time-consuming exercises such as the EAE project, since frequent smaller projects will keep the teachers and managers oriented towards the constant use of stakeholders in quality assurance.

There also seems to be a difference in perception between management, teachers and students as to the extent of involvement of industry. The lower down in the organisation, the less the school is perceived to involve the industry in quality assurance. This may, perhaps, be due to differences in knowledge about the actual level of involvement, in the sense that teachers and students are not aware of the involvement of industry in educational boards and/or projects.

The interpretation of industry may also be a bit narrow. It seems to the panel as if industry is mainly understood as manufacturing and production-related industries, whereas governmental companies and organisations, voluntary organisations and even service-related industries, such as consulting companies, maybe fall outside the scope of KTH. If this is true, it does not reflect the real situation when it comes to work organisations very well.

Internal stakeholders should also be more involved. In this regard, the school seems to have good examples to draw from, particularly related to the way that the CENMI programme bridges four different schools and the way in which the CINEK programme cooperates with other schools to create technological specialties for its students. It seems, however, to be a danger signal when management talks about wanting to hire its own staff for teaching, e.g. mathematics and physics, instead of building good relations with existing competences within the KTH organisation. Such independent environments may seem enticing from a control perspective, but tend to create problems with the critical mass of staff within one area, which is necessary to prevent stagnation. Also, such actions tend to increase the self-centeredness of the school. It is also important to integrate the students from different programmes, at all the KTH schools, with each other.

PREREQUISITES

Most students claimed, when asked, that they experienced their teachers as highly competent, and particularly that they had a high level of knowledge of their respective fields. The limited criticism that emerged was usually linked to the limited pedagogical skills of some of the teachers. When teachers were asked, they gave praise to the pedagogical course that has now been made mandatory when new staff members are recruited.

Also, teachers said that there were a lot of voluntary courses and seminars put up by management that had a high level of attendance. They stressed, though, that participation in such courses and seminars should continue to be voluntary. Here, the panel believes that management should decide on a minimum level of pedagogical background. In addition to this minimum level, management should encourage teachers to continuously improve their teaching skills by studying at international universities or at KTH.

The school management explained the new tenure track system at KTH. From what we were told, this seemed like a good way of upgrading teacher competences and to think in terms of career development for scientific staff. This seems like very positive programme. If possible, the panel urges management to think about how this system can include more appreciation of teaching skills and teaching competences and not only research work. We do know, of course, that this must also be a KTH-level programme, but we still think it is worth considering and bringing into the central debate about career planning.

One recruitment issue that we observed was the feeling we got that a large percentage of the students in the programmes at KTH are from the greater Stockholm area. Almost all students we talked to (except the international ones) were from this area, and the programme and school management confirmed that this was the case. The school management talked about a gentleman's agreement with other technical schools that no one would actively recruit from the other university's territory.

This lack of competition could become a problem, since it means that, in some economic sense, it is sufficient for KTH to be the "best in Stockholm", and this would again mean that there is little incentive to become better at education, since they cannot attract significantly more students anyway, and if they could, they would not have quotas to increase the number of actual students. Management thus needs to find other reasons for working with quality, or the need to improve may disappear among the teaching staff.

On the positive side, most of the programmes at the ITM school seemed to have very good applicants with high marks. This means that students are among the very best academically, and usually also means that they are highly motivated. This in turn leads to challenging students to teach, something which most teachers find rewarding in itself, even if it increases the workload. This is a strength of the ITM school, and activities should be considered to maintain this favourable situation. It seems to be a challenge that the main recruitment activities are carried out centrally, a fact which sadly limits the opportunities for ITM school management to implement such activities. Ways to get around this problem should be considered and KTH policy should perhaps be challenged.

EDUCATIONAL PROCESS

We felt that the process of constructing learning outcomes at programme level was generally well taken care of. The different programmes seem to have taken this task seriously, and the results are solid and, in some cases, even impressive.

However, there are signs from the interviews, as well as from the self-evaluation process, that there is still work to do when it comes to a general involvement from teachers and students in the interpretation and communication of the learning outcomes. As the process is still fairly new, we expect that this will come with time, since we can see that management is aware of this challenge and has activities in place which are likely to take care of this challenge.

One area where management could do more is probably to be better at sharing best practices in teaching. Teachers seemed to feel a lack of support from management and experienced little interest in their attempts at using new teaching methods. A lot of similar initiatives were described for us by teachers, but they spread out mainly through formal and informal teacher networks, and not as a result of organisational routines to capture and spread successful initiatives. Teacher meetings seemed to be the best vehicle for such sharing processes, but management should look into the possibility of complementing this with more formal methods and support in form of manpower, external experts and perhaps in the form of pilot projects, including CDIO methods. More informal methods, such as peer presence when other staff members teach, could also be used.

In general, teachers felt that programme managers were more likely to see them as individuals and take an interest in exactly what they were doing and how they were doing their teaching, whereas line management seldom showed an interest, particularly when things were perceived as going well.

It is a generally accepted strategy for management to avoid looking only at problem-solving but also to involve themselves when staff is doing well and performing adequately, and it seems as if line management could improve in this regard.

We also perceived that teaching has low status at KTH. This is a common challenge for all universities, as research and publication strongly dominate when it comes to future career opportunities. While this challenge cannot be solved completely within one particular university, and definitely not within one of its schools, it nevertheless requires line management to invent ways in which teachers can be supported.

The general impression of the current situation, when talking to teachers, was that they were somewhat resigned, and there was much commenting on the fact that "it would be better for us/our career to do research, but we like to teach" or "the only reward we get is when we have spent a lot of effort on a challenging concept and can see that the students actually understood what we were trying to explain!" This situation, where teachers engage in teaching solely on the basis of personal interest and/or out of sympathy with the students, is not good. Teachers need to know that their teaching is important to the goals of the school and that their teaching can help their career. However, exactly how this can be remedied is difficult to say. Be sure to tell us if you find a good solution though, as most of us are searching for such a solution!

Teaching methodologies were found to be rather traditional. In addition to lectures and exercise work, project work is used quite a lot, and sometimes also in cases and assignments. However, students did not indicate that this was a problem. They are quite used to such teaching methods and expect to find them, and thus are not necessarily reacting to the lack of new and more innovative teaching methods. When talking to teachers, we discovered that many of them were constantly testing out some more innovative methods in their courses. Thus, there seems to be an interest in developing teaching methods, but, as mentioned above, there seems to be a lack of routines and procedures for disseminating such methods and the experiences made when testing them, and as such, all these various initiatives made by teachers remain a local and limited initiative. We therefore suggest some sort of routines and procedures for sharing practice between teachers.

There also seems to be a lack of cross-disciplinary teamwork. Other universities, for example Delft and NTNU, have project courses where students from different programmes and disciplines work in cross-disciplinary groups on a common problem, often one contributed by industry or other external stakeholders.

It is important for the students to have this kind of experience, as it is similar to real-life working procedures, and we recommend that the school management and/or programme management look for ways to integrate such projects, either in existing courses or as a separate course.

Teaching methods also seem to be directed towards students as a group. In large courses, in particular, the individual student is seldom seen. This means that many students do not bother to go to the lectures, and in this way it is easy to fall behind, and, as a result, retention rates may suffer. We therefore suggest that the school and/or programme management searches for a way in which some focus can be given to the individual students and their personal development. One suggestion is to consider a system of individual scorecards where learning outcomes are listed and the student and/or teacher can record when they have performed activities which are a step on the way to reaching those learning outcomes. This system may be most relevant for the "soft" skills, since these skills are not normally taught as separate courses, but rather as components in many different courses. To have such a scorecard may then be a way of linking the soft skills learned in different courses and ensuring that there is a progression in these skills throughout the education process. This idea received some positive feedback from teachers, but it needs to be developed and adapted to the learning outcomes of the programmes in the school before it is implemented. Such an individual focus on each student's progress to achieve the learning outcomes would probably help with student retention, as it would explain why they would personally need to progress.

LEARNING OUTCOMES AND THE QUALITY OF EVIDENCE TO SHOW THAT STUDENTS HAVE MET THEIR EXPECTED LEARNING OUTCOMES

As mentioned above, the process of developing and using learning outcomes to govern the programmes and courses delivered seems well on its way at programme level, but there still seems to be some work to do in order to link these learning outcomes at course level. This is a challenge particularly in relation to engineering skills in a broader sense (soft skills), since the programme needs to ensure progression within these skills as students progress from course to course. This can be particularly tricky, since students at a higher level do not have the same course portfolio. Also, learning outcomes should be closely linked to teaching methods, so that students experience a variety of teaching methods in different courses. As to the learning outcomes themselves, the panel felt that there were quite a high number of them, and this may impede focus.

Also, the implementation of learning outcomes seemed to be handled very much as a yes/no question. For example, if the learning outcomes require students to learn something about sustainability, they get half a course on sustainability and then this learning outcome is checked off.

We would like to see a more continuous scale being used for the most important learning goals, so that the learning outcome is ranked as excellent/good/sufficient/poor, rather than yes/no. This is valid both for internal use and external presentations.

The project reports that were presented to the panel were difficult to relate to (see also Feedback regarding the EAE methodology). We were, however, not impressed by the thesis work, and particularly not by the students' ability to observe and comment on broader issues related to the problem they were discussing. Reports were narrow and focused on the immediate problem at hand. We are, however, uncertain about what this represents and whether this is related to traditions for thesis writing or whether it is representative of the competence of students in general.

A grading system of the thesis, based on the expected level of learning outcomes demonstrated in the overall thesis work, would help to improve the work of each student as well as identify the need for improvements within the programmes. We are concerned that the KTH culture is underestimating the importance of an engineer to have "soft" skills in the future.

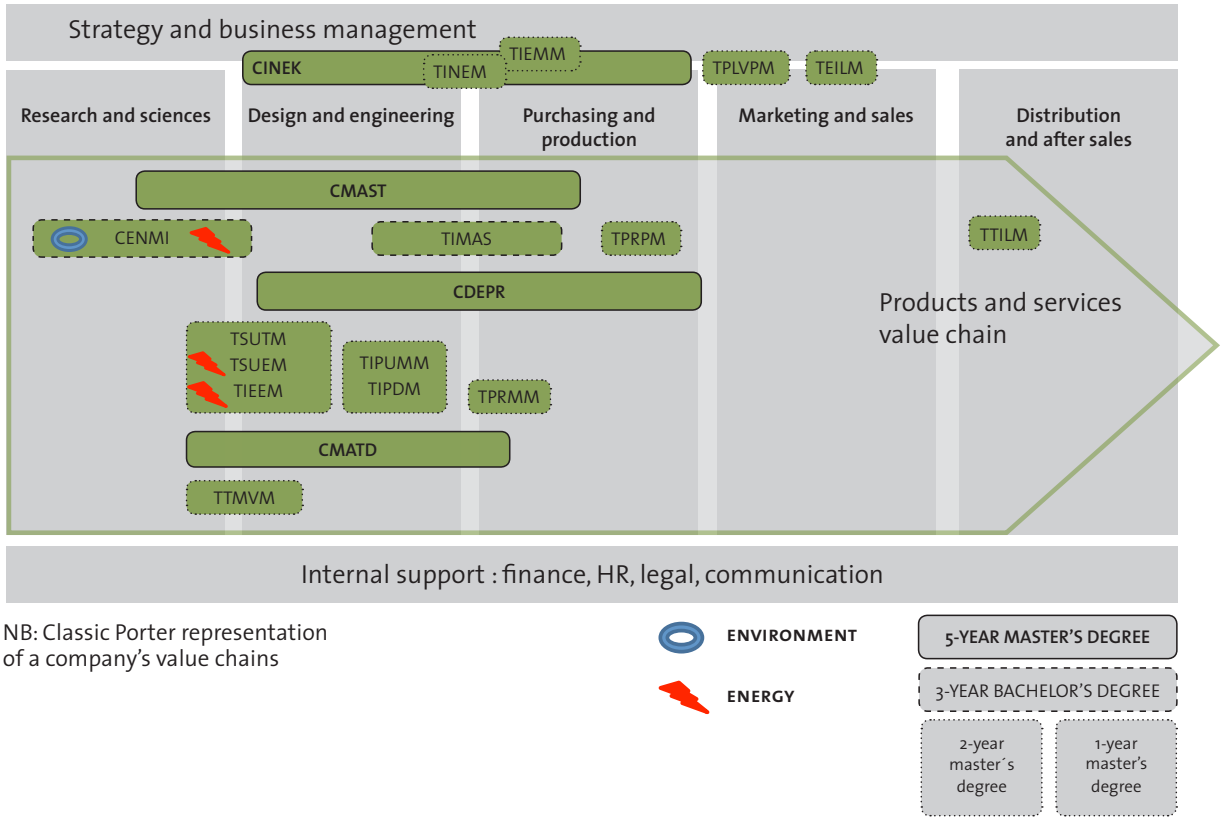
A recommendation we would like to make is to include explicitly creative techniques (e.g. Edward de Bono) into the curriculum. These are probably best situated within a course with a large design component, since it is very important that a future engineer can think "outside the box" and come up with creative solutions.

STUDENT RETENTION

From what we have understood, programmes at KTH operate under a quota system. This means that a programme can only accept a specific number of students. The student retention rates are very important measures to follow.

Good statistics for student retentions, reasons for students dropping out etc., is an important starting point for identifying and implementing improvements, but these do not seem to be covered in a systematic way.

ITM SCHOOL 19 PROGRAMMES INDUSTRIAL COVERAGE



NB: Classic Porter representation of a company's value chains

Several programme managers claimed that they did not get good enough statistics and that they did not have individual data as a basis for understanding the actual situation, and this seems to be a problem. We would recommend that more emphasis is directed towards getting good data on this, and, if necessary, that the school (or the programmes) creates the necessary data itself. It is possible for study counsellors to create and update a simple excel file or a database of individual students which can give managers easy access to the data they need to handle this situation.

One action which has been taken is that students who fall behind in their exams are singled out and invited to a meeting with the student counsellor. They are then given help to construct an individual study plan which will bring them back on track. This is a helpful measure, but also problematic in that it is only a reactive measure.

A better strategy would be to invite every student to an interview about their study situation. In this way, opinions can be sought on a range of issues, and this information could be very helpful in improving the programme. Also, such a strategy would mean that all students would feel that they are seen, and not only those who are not doing as well. Such a strategy would therefore be more proactive than reactive, but would not rule out the above measures also being undertaken. Some of the interviews seemed to indicate that smaller master's programmes already had such measures in place, so maybe they can be identified and the way they do it can serve as a model for other, larger programmes.

We had a good impression of the programme managers and the way they worked with teachers and students to improve the programmes, as well as the quality of the learning environment. The programme committee seems to be a good tool for the students and teachers to influence the programme. Also, teachers seemed to work well with each other in formal groups, as well as in informal settings. Nevertheless, the panel felt that sometimes the focus of the organisation was more on the programmes and the way they were constructed rather than on the actual students who followed the programmes. As mentioned above, the panel believes that it is also important for students to be seen as individuals, and we therefore encourage the organisation to think about ways in which this can receive a higher priority, as we believe that if such measures can be found, they would increase the retention rate.

GRADUATE EMPLOYABILITY

Employability is not a problem at present, but how well is KTH prepared for the future? How do engineers from KTH and ITM prepare for different scenarios? Are they well prepared to work in a changing world? For example, will they work in a time of economic crisis? In 20–30 years' time? What about the growing international completion with other universities? We see a need to move from business as usual to a more future-oriented approach to higher education.

This issue may also touch upon the number of programmes at the school. We believe that the number of programmes is rather high. If all these programmes are needed, it may be the case that the engineers educated from the school are too specialised for the changing world in the future. Perhaps it would be better to educate more generalist engineers (and correspondingly reduce the number of programmes). The CENMI programme could be an example of a sufficiently broad programme.

We believe that all programmes seem to be well covered when it comes to technological subjects and natural basic science courses. However, soft skills are also needed, and it is unclear to us whether these skills are actually handled well. The self-evaluation reports indicate that soft skills are developed in almost all courses, but we believe that structuring and progression in these skills may be not handled well. Somebody (perhaps the programme board), needs to make sure that there is progression in soft skills, such as group work, leadership skills, presentation skills and project report writing, and this involves more than just including a project report in a course.

In some programmes, alumni survey answers indicated that the programme content was not totally well adapted to future employment, but no questions were asked regarding what was missing. Such open questions regarding "what was missing from my programme" would help the programme managers.

Currently, it seems as if most students who graduate are actually employed. In fact, several interviewees mentioned that many students are employed before they graduate (while they still have not completed their programmes). This is a problem for both KTH and society, and one suggestion is to make contracts between industry and KTH on how the degrees should be completed.

STUDENT SATISFACTION

During the interviews, students, almost uniformly, had positive comments about their programme, the courses, the teachers and the influence that they had on the development of programmes. Teachers were perceived to be generally very good, some were excellent, and it was felt that just a few teachers should improve their teaching skills.

Students gave the impression that all programmes required a lot of work, but not too much. The general

impression was that the top programmes required far more work than 40 hours a week, but most programmes reported the workload to be at least 40 hours a week.

Students mentioned several success stories in improving the quality of the programmes and of single courses, and they repeatedly mentioned that they were listened to. They also claimed that they had easy access to teachers and that teachers took time to work with them. In general, students seemed proud of their institution and their programmes, and most would recommend them to friends and relatives.

Some students said that they were "surprised" by the content or progression in their programmes, but this was generally not taken negatively. This may indicate that more information is needed, but it is not easy to find good ways of explaining this.

SUSTAINABLE DEVELOPMENT

In most programmes sustainable development seemed to be mentioned, but generally it was included as one additional course or as small parts in a larger number of courses. We encourage the programme managers to think more holistically about how this concept can be handled.

Sustainability needs to be understood in a broad sense, combining societal concerns, corporate social responsibility, economic sustainability, environmental consequences, full product life cycles and recirculation, among other things. We were surprised that this holistic view seemed to be absent, at least in the four thesis reports that were presented to us.

The new sustainability coordinator at KTH has been invited to TU Delft to see what attempts have been undertaken there to implement sustainability into the various curricula.

INTERNATIONALISATION

Most students commented that they wanted to go abroad, but for most programmes this never materialises. Only one programme, the CINEK programme, had very high numbers of students abroad. In addition, the TIIEM programme has a mandatory stay abroad. When questioned, students claimed that many of the reasons for not going abroad were related to organisational reasons. Difficulties in getting courses accepted, not enough attractive exchange places and little encouragement from teachers and management were mentioned. When talking to representatives of the CINEK programme, they mentioned exactly the same things and presented what they had done to eliminate these challenges. They also had their own international coordinator, but it was unclear whether this was a consequence of the high degree of internationalisation or a cause of it.

Thus, the panel concludes that there is an excellent example to learn from within the school, if the school wants to become better at sending students abroad.

When talking to teachers, it seemed as if very few of them had even considered going abroad for educational purposes. No one among the school or programme management mentioned any procedures in place for encouraging this. The panel recommends that the school should consider using international research networks to further enhance exchange programmes. This can be done by involving research networks in creating agreements and supporting and encouraging student exchange, particularly for thesis supervision. An exchange for guest teachers should also be encouraged, but this needs financial support to some extent.

Incoming international students struggled with being integrated with Swedish students and society. One possible solution could be to offer Swedish language classes for international students. Another solution would be to think more thoroughly about how integration can be achieved. This is a case that needs teacher and programme management support, particularly in the beginning. Student organisations can also be drafted to help with these, but should not be expected to take sole responsibility for such activities.

The recent introduction of tuition fees for non-European students represents a challenge. Some programmes may have to close as a result of a lack of international students. It seems as if management has not decided what they really want to do with this. If they are interested in keeping foreign students, efficient policies are needed, such as contact with companies who are willing to subsidise students for these programmes and/or recruitment in other educational markets which are used to paying for tuition (UK, USA and others). Semester/full-year mobility of students from KTH and incoming students from other top European institutions would not have any (or limited) financial impact on the programme and would also facilitate international exchanges of best practices between various programmes on similar subjects in different institutions. This would also support guest teachers visiting.

DIVERSITY AND GENDER EQUITY

Being a typical engineering university, KTH currently has a large imbalance in the gender distribution of teaching staff. The ITM School is one of the better KTH schools in this regard, and the school management and department management also seem to have programmes in place which slowly, but surely, seem to be improving the situation.

As recruitment is handled at department level, this situation seem to be well in hand, but there is still a long way to go, particularly within the more technical areas, so management need to keep up the pressure.

When it comes to the situation for students, the situation varies greatly from programme to programme.

Some programmes have a fair situation when it comes to gender balance (for example CENMI and the design programme), whereas others still have a way to go. Surprisingly, the CINEK programme still has less than 30 % of women in their programme, which is low compared with other programmes at the ITM school and also compared with similar programmes at Chalmers and Lund universities. Students clearly wanted the gender distribution to be more balanced, and almost all students, regardless of their programme, claimed that it was better to study in mixed-gender groups than in single-gender groups.

However, no one that we asked, management, teachers or students, seemed to have an idea of what activities to put in place to improve the situation. Students mentioned two main reasons for this situation: the fact that KTH had a reputation as a "nerdy boys" school and the fact that the CINEK programme strongly emphasises that it is an engineering programme. Several students and teachers also mentioned the name as a possible reason. "Call it something with environment and more girls will apply", was something we heard from more than one person. The strong emphasis on technology can be linked to the learning approach, but it does not necessarily seem like a good idea to change this, as this would make the programme less distinguishable from business schools, and that would not be desirable.

EVALUATION BY PROGRAMMES

In all, 19 programmes were evaluated for the ITM School. They consisted of four 5-year master's, two 3-year bachelor's, nine 2-year master's and four 1-year master's degrees.

Although the programmes as a whole cover the industrial and management needs of the industry, it seems that a certain restructuring of the programmes would support an increased visibility and attractiveness of those programmes for both the students and the companies (or other stakeholders). It would facilitate the communication towards students who would then better understand what the programme does. It would also enable some programmes to be widened to cover more areas within companies.

Some programmes are targeted at functions within the companies (design, engineering, production, industrial management, project management, entrepreneurship, logistics), others on application areas (mechanics, materials) and others on application domains (energy, environment). Some programme's names are very difficult to understand.

Choices will have to be made to simplify the programme on offer and facilitate an understanding for non-specialists, such as the students, their families and upper secondary school teachers.

Paths should be designed within ITM to enable the students to apply from any of the ITM bachelor programmes to any of the ITM master's programmes (or 5-year programmes, as long as they remain in the programme offer), for example, by identifying additional courses the students would have to take. This approach would make the ITM programmes more attractive for the students and help to redirect students towards the programmes best adapted to their abilities and interests.

Particular attention should be paid to the 1-year master's. These are very interesting as they answer to business needs/functions which are not covered by other programmes. However, the name "master", which refers internationally to a 5-year graduate degree, is misleading in these cases (bachelor + 1 year). Would it be beneficial for the industry to make them 2-year master's? and/or develop them as executive education programmes? are questions the committee would recommend raising.

The graphic below shows how the programmes of the ITM School are spread when applied to a classic Porter representation of a company (cf. Michael Porter who is famous for his work on company's value chains).

Feedback regarding the Master of Science in Engineering in Energy and Environment (CENMI) programme

STRENGTHS

The broad scope of the programme at bachelor level, shared between schools, will improve engineer flexibility in a global and changing competitive business world. The motivation and high level of achievement of the students, the teachers and programme managers' commitment and enthusiasm are clear assets to maintain. "red thread" courses, where all courses in one year are pulled together, are an excellent idea in order to pull the programme together. Good gender balance. Friendly competition between teachers from different schools in order to attract students to their specialisation leads to higher standards of teaching.

WEAKNESSES

Stakeholders should be involved in the programme design from start – although all students apply for a 5-year programme, the market for bachelor jobs should also be taken into consideration. Familiarity with complex system methodology is crucial to the success of the engineer in the workplace. This should be a prime focus of the programme, but it is unclear to us whether this is the case, since the programme is still a work in progress.

OPPORTUNITIES

Soft skills and the internationalisation of the programme would be a real additional asset to the programme, and particularly since the programme has highly motivated students and is highly visible to stakeholders. Using this programme to test a pilot organisation to facilitate the funding process and the decision-making process for cross-school programmes is recommended. "Red thread" courses are good examples of CDIO in practice, and could serve as a model for others.

THREATS

Cross-school programmes are vulnerable to politics and need a lot of attention and political manoeuvring. Friendly competition between schools, as mentioned above, needs to be balanced by a strong programme focus to maintain programme cohesion. Too much overlap with other programmes.

RECOMMENDATIONS FOR THE FUTURE

Make the differences with other programmes explicit. For example, what is the difference compared to other KTH programmes and what will it be with, for example, Industrial Ecology MSC programmes at other universities? Are CENMI graduates Engineers of Sustainable development as mentioned the self-evaluation report)? And what does this mean?

Feedback regarding the Master of Science in Engineering in Industrial Engineering and Management (CINEK) and the Master of Science in Industrial Engineering and Management (TIEMM) programmes

CINEK

STRENGTHS

Strong recruitment, strong and ambitious students, well-handled cooperation with other schools in relation to technological specialisations, well-developed procedures for exchange and a high percentage of students with international exchange experience, excellent work opportunities after completing the programme.

WEAKNESSES

A gender imbalance in the programme (particularly when compared with other industrial economics education in Sweden), challenges with securing commitment from teachers not in the ITM school (particularly for basic natural science courses), many of the master's courses are still in Swedish, making it difficult to accept international students into the programme.

OPPORTUNITIES

Excellent placement of alumni in important management positions opens up for a lot of possibilities for close interaction with industry. High awareness among students about the need for international experience should lead to possibilities for international contacts.

THREATS

Contact with industry is narrow, municipalities, public companies, voluntary organisations, service companies and consultant companies should also be considered relevant to the programme. Undercapacity of permanent teaching staff.

RECOMMENDATIONS FOR THE FUTURE

A figure in the self-evaluation report indicates that more than 80 % of students feel that the degree of difficulty is just right, which is quite high. This can be seen as a sign that the students should be more intellectually challenged.

Feedback regarding the Master of Science in Engineering in Mechanical Engineering (CMAST), the Master of Science in Engineering in Design and Product Realisation (CDEPR), the Master of Science in Industrial Management (TINEM), the Master of Science in Production Engineering and Management (TPRMM), the Master of Science in Engineering Design (TIPUM), the Master of Science in Integrated Product Design (TIPDM), the Master of Science in Sustainable Energy Engineering (TSUEM), the Master of Science in Innovative Sustainable Energy Engineering (TIEEM) and the Master of Science in Sustainable Technology (TSUTM) programmes

CMAST

STRENGTHS

Strong programme, focused on key engineering issues and well received by students, good level of industry contact with field visits and other activities, good use of computer-based learning systems and up-to-date laboratories, the programme manager follows up each individual student through a personal interview.

WEAKNESSES

Too many master's within the programme are diluting the visibility and competing against each other. The panel advises the programme management to simplify the structure and improve the naming of the master's. A low level of collaboration between programmes and departments leads to too few best practices being shared. Severe gender imbalance among students reduces the effectiveness of the learning environment. Little integration of economic sustainability and the marketability of new products.

OPPORTUNITIES

Embedding sustainability and internationalisation in the programme structure would improve the usefulness of the engineer in the workplace.

THREATS

Image – as a "male" programme may be a challenge to correcting the gender imbalance, manufacturing industry is becoming less important, so contact with industry may need to be broadened.

Feedback regarding the Master of Science in Engineering in Materials Design and Engineering (CMATD) and the Master of Science in Engineering Materials Science (TTMVM) programmes

CMATD

STRENGTHS

Excellent academic level of the teachers, good research connections and strong research programmes handled by the teachers.

WEAKNESSES

Programme content seems to be too narrow and a bit old-fashioned and concentrated on metals, paper and ceramics, compared with the industry requirements in innovative materials (e.g.: bio materials). Student recruitment level is low, both academically and in numbers (few applicants). Teachers' balance between research and teaching and/or programme management should be improved towards more importance given to teaching. Students seemed quite reluctant to recommend this programme to their friends and relatives, indicating a general dissatisfaction with the programme content and management. The programme seems to focus too much on materials and their qualities and not enough on their use in practical applications.

OPPORTUNITIES

It is an important programme for the Swedish industry, and this should enable KTH to find development partners for further development of the programme, and expanded programme coverage of new materials should improve its relevance and attractiveness to students and stakeholders. Improve programme promotion to improve student recruitment to additional bachelors, such as mechanical engineering. More attention should be given to individual students, and student feedback is necessary to improve general satisfaction. New materials and new uses for them are invented every day, so students could benefit from more soft skills, particularly related to innovation, product-integrated and sustainable design as well as entrepreneurship. Could benefit from benchmarking with similar programmes in other excellent universities.

THREATS

The image of the programme is not very attractive and hides the importance of the programme content to Swedish industry. A change of programme name may be useful, or perhaps better marketing of the programme's content could be sufficient.

Feedback regarding the Bachelor of Science in Engineering in Mechanical Engineering (TIMAS), the Master of Science (1 year) in Product Realisation (TPRPM), the Master of Science (1 year) in Project Management and Operational Development (TPLVM), the Master of Science (1 year) in Applied Logistics (TTILM) and the Master of Science (1 year) in Entrepreneurship and Innovation Management (TEILM) programmes

Many of the teaching staff seem to have a limited academic background, which is explained by the professional focus of the programmes. However, a collaboration between professional and academic teachers would certainly complete the current short-term focus of the education provided to a more midterm focus. Several teachers will retire shortly, which will provide KTH with an opportunity to recruit new teachers.

The programme's contents covers very useful domains in the companies: project management, entrepreneurship, logistics, innovation etc., which are very clear and attractive to students and industry. Those programmes have many applicants and students. Programmes with a 1-year duration period are also attractive. Some innovative teaching methods were employed. The Committee recommendation would be to better integrate those programmes with the bachelors and other 2-year master's degrees.

The 1-year programmes were particularly attractive to foreign non-European students: tuition fees may have a negative impact. Due to the language issue, those students were not easily employable in the Swedish industry, which does not enable alumni follow-up. The campus location, quite far from Stockholm, is less attractive to Swedish students, despite the good housing conditions. However, high-quality programmes that are well connected to the other ITM programmes and are highly internationalised (both in duration, content, students and teaching staff) could become very attractive. This is the integration approach, whereby one tries to incorporate Södertälje better into the KTH as a university. A segregation approach can also be considered, whereby Södertälje campus, with its programmes like TIMAS, is recognised and supported in its strengths; educating students to become well-trained industry professionals, yet at "college level" rather than at "university level". There is nothing wrong with this, there is just a difference that cannot be ignored. This is an international discussion that cannot easily be solved, but a clear standpoint should be taken.

Feedback to KTH management

The panel has sensed a gap between the different levels in the organisation, especially between the school management and the programme managers and the teachers, and probably also the students.

- For the visibility and the clarity of the programme supply, it would be advisable to have fewer programmes that are subdivided into different tracks.
- Both students and teachers must be encouraged to go abroad for at least one semester.
- A tenure-track for teachers should be developed.
- Education should be developed from "business as usual" in the direction of a future-oriented approach for engineers in a changing word.
- Expand the understanding of stakeholders and use their knowledge when developing teaching and programmes.
- To achieve a position as one of the top-ranked universities in Europe, the recruitment base should be enlarged to cover the whole of Sweden. In some focus areas KTH should be an attractive choice for students from all over the word.
- There is a need for individual student progression follow up. The teaching must focus on the students and the individuals.
- The list of learning outcomes is too long, this list must be more focused.
- A strategic decision should be made regarding Södertälje campus and its programmes, such as TIMAS. Södertälje campus should either integrate to university level or be segregated and remain at college level, either outside or within KTH.

Feedback regarding the EAE methodology

In terms of the process of evaluation, we would have liked to have more master's thesis reports to make a better comparison and judgements on the quality of the reports. If possible it would have helped to have had an indication of the level of the grading of the work as it is done by KTH staff or, if there are no grades, the degree to which the student, his/her work and his/her report meets the learning outcomes.

We also would have liked to discuss with the staff member who served as the tutor in the respective MSC theses (only one person (from TIMAS we believe)) if they could provide information on one of the four MSC theses presented to us.

The students we interviewed were almost all engaged in student committees, unions or similar organisations, and not randomly picked. It is likely that this has affected the conclusions we can draw from the interviews.

The questions used for the student questionnaires should be critically reviewed by experts in designing questionnaires.

There must be time for site visits, including excursions, or case descriptions about creative solutions, learning environments or applications on modern pedagogy.

Engineering Sciences (SCI) Sub-panel report

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Martyn Hill, University of Southampton
Teresia Olsson, Lund University (student representative)
Kristian Ranestad, University of Oslo
Göran Sjöberg, Volvo
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Feedback to the self-evaluation groups and school management

GENERAL OBSERVATIONS AND IMPRESSIONS

The educational programmes at SCI are relevant and ambitious programmes that attract very able and dedicated students. There is evidence that the employability for the graduates is very high and stable. The teachers are, in general, very dedicated, ambitious and very involved in the programmes. It is common practice in most of the programmes that the teachers meet regularly to discuss courses and teaching. Some programme management groups (particularly for the 5-year programmes) are very dedicated and have a clear vision.

At all levels, management has shown a very constructive engagement with Bologna while maintaining the benefits of the 5-year integrated programmes at the same time as the final 2-year programmes are opened for external students.

Despite the favourable conditions for teaching and learning, the students' results in year 1 are poor and, in some cases and years, very poor. Also, the number of dropouts is high. In fact, the circumstances are worse than many similar programmes in Sweden. It seems that there is a culture among management, teachers and students that accepts this as being the norm. The most common explanation is that the recruited students do not have the required skills or knowledge in mathematics. A more constructive explanation was offered by one programme director: the maths courses are not aligned to the maths education at upper secondary level.

BEST PRACTICES

The CDIO (Conceive-Design-Implement-Operate) approach is significant and provides a framework for the integration of general engineering skills as well as for programmes to continue to develop and improve, as it provides an excellent framework for real-world problems, systems and project management.

Moreover, the CDIO engages teaching staff and students in the course development in a general manner.

It is encouraging to observe the high degree of implementation of the CDIO approach in the 5-year engineering physics programme. In the 5-year programme in vehicle engineering, the CDIO approach is manifested by integrating ways of teaching and learning communication, the programme learning outcomes and in the realistic design-build-test projects. Methods developed by the programme in vehicle engineering have been adopted across universities worldwide.

The Kaizen quality circles in the 5-year programmes that meet every second or third week are examples of best practice that increase the engagement of teachers and students in a positive teaching culture. Specifically, it gets the teachers involved in the programme and makes them feel more responsible for the programme as a whole. However, it seems that mostly course planning and not long-term development of the programmes are on the agenda.

There are some examples of excellent practices in the self-evaluation process that include students, industry, teaching and management. The process itself has been valuable in that it has strengthened the teaching culture, increased the awareness and involvement in the programme as well as put education on the agenda.

CONCERNS

Organisation responsibility structure and practice

No clear procedure or practice for the strategic development of programmes. Weak involvement of industry and other stakeholders regarding programme quality enhancement.

As we understand it, KTH splits responsibility for education between the faculty, school and departmental levels, with boards as well as programme directors for 5-year programmes and master's programmes. Programme directors were not clear to whom they should report. It is unclear who is taking the strategic decisions regarding programmes and courses. Programme directors expressed frustration about not being able to influence which teachers teach the courses of the programme. Moreover, programme directors have a small budget for development, but we learned that the main part was used for extra-curricular activities, e.g. SI, introduction of students and recruitment. Although 5-year programme directors have the responsibility for the integrated programme, they have no formal influence on the content of the master's programmes.

Recommendation
Clarify the responsibility between departmental directors of studies, the school director and programme directors. Make the master's programme directors answerable to the 5-year programme directors. Make the 5-year programme directors responsible for the development of programmes and give them the power and budget to make decisions. Introduce a differential system for the allocation of resources to courses and put the 5-year programme directors in charge of the system. Implement a quality assurance circle at programme level. Establish boards at programme level with participants from the industry and other stakeholders.

1st year maths education
In general, students do not appreciate the maths courses and the results are poor. The students do not recognise and understand why they study mathematics. This lack of motivation is cumbersome. We learned that the same maths courses are given for all programmes except for engineering physics. We have found that a 5-year programme director has planned to develop a more integrated maths education, but so far this has had a limited impact. It is obvious that the CDIO approach has not been merged into the maths education. A cumbersome fact is that the departments of mathematics and numerical analysis are separate and located at two different schools.

We learned only briefly of a newly implemented revision of 1st year maths courses and did not have the opportunity to discuss this with the programme representatives.

Recommendation
Develop the maths education in close cooperation with programmes. Consider integrating traditional and numerical analyses and transfer the focus from solving special problems to more open problems.

General lack of awareness of the sustainability agenda
The strategy at all levels of leadership is to integrate sustainability in the courses where it is appropriate. When integrating sustainability in the courses, when appropriate, our concerns are that no course or teacher takes the full responsibility for sustainability issues and that it can be difficult to include general aspects of environment and sustainable development, with emphasis on global perspectives. Furthermore, we have learned from the faculty as well as from the students that evidence of integration is missing, with a few exceptions. One outstanding exception is the Thermodynamics course for 1st year engineering physics students.

The course successfully integrates sustainability in a natural manner and can serve as a role model for this integration. Although they find it very tough, the students sincerely appreciate the course and we find that the students have a genuine interest in sustainability.

Recommendation
Develop and implement programme-level strategies for inclusion of substantial sustainability education. Make 5-year programme directors responsible for this. Consider including a separate course on the general aspects of sustainability or including substantial blocks on general aspects in the introductory courses of the programmes. If a separate course is implemented it is very important that it is developed in close cooperation with the programme to make certain that the students on the programme understand the relevance of the course and its relation to the rest of the programme. It is also of great importance that, for each programme, it is possible to pinpoint the moments where sustainability issues are addressed to be able to see the progression during the programme.

Use of Swedish in international master's programme
We observed that a high number of master's degree projects were written in Swedish (two of the degree projects sent to us were written in Swedish). Furthermore, we learned that exam and test problems/questions were given in Swedish and English and that it was common practice that exams could be answered in Swedish. We found this inappropriate and unfair and a barrier to the integration of students. Master's theses and exams/answers written in a national language do not fit into an international programme.

Recommendation
Use English at master's level.

Lack of internationalisation and globalisation of engineering in educational programmes
During the visit, we did not discuss how internationalisation and globalisation of the engineering profession is reflected in the educational programmes. From self-evaluation reports and other materials, we do not see any plans or evidence of this. Engineering is truly an international branch and most of the graduates will work for global companies and in multicultural project teams.

Recommendation
Ensure that the international master's programmes have an international environment. Consider having team projects, where teams with different nationalities are put together. Consider exposing students (including bachelor level) to the global nature of engineering both through joint projects, real-world international scenarios and exchange programmes. Carry out an analysis of the international nature of engineering work in the 21st century so that the programmes can ensure that the graduates are well prepared to work globally.

Lack of control of assignments for final degree projects
We found that there is a wide spread of themes in the master's theses. In some cases there seemed to be a weak link to the disciplinary knowledge that the student has learned in the programme. We also found out that no individual with responsibility for the programme approved the master's theses suggestions before the students actually started their thesis work.

Recommendation
Make the master's programme director responsible for approving theses project suggestions prior to the start of the projects.

Weak student feedback mechanisms at master's level
The mechanisms for the programme management and teachers to obtain feedback from students seem to be weak, and in some cases non-existent, at
master's level.

Recommendation
Use course and programme evaluations at master's level. Make the master's programme director responsible for this.

Weak or non-existing introduction of students joining at master's level
It is very important for students who join KTH at master's level to have a proper introduction, both from an educational and social point of view. The introduction gives the students the opportunity to meet fellow classmates and form study groups. The introduction can also be used to integrate native and international students.

Recommendation
Develop a model for the introduction of students joining at master's level and make master's programme directors responsible. Consider using the introduction as a tool to integrate native and international students.

Course evaluations
We have seen some good examples of course evaluations with mid-course meetings, final meetings and questionnaires that can be filled in anonymously. However, this does not seem to be common practice. Much of the responsibility lies with the students and two parallel evaluation systems seem to be in service. The most ambitious one is the one driven by the students. The one driven by KTH is, as far as we understand, based on a web questionnaire on the learning platform. The response rate and the student feedback are very poor for the latter one.

Recommendation
Together with the students, develop and put into practice a compulsory standard course evaluation system based on mid-course meetings, questionnaires, final meetings and a channel for feedback to the students.

Apparent trade-off between research and teaching
The leadership of the school claimed that educational merits are very important, and in some cases just as important as research merits in the progression of the teachers' careers. In interviews with junior teachers the panel has found evidence that this has not come through. It seems to be a fact that research merits are given a substantially higher weight.

Recommendation
The panel recommends the leadership of the school and KTH to encourage the teachers to create pedagogical portfolios and to seriously take those into account in salary discussions as well as in promotion applications and career planning. It is not how many points in pedagogy one has that matters, but how it is practised. Moreover, the leadership should encourage the teachers to present and publish their educational/pedagogical developments and innovations at engineering educational conferences as well as in engineering education research journals. This is an emerging and important research field. It is important that all levels of the KTH leadership acknowledge these publications as potentially equal to the traditional engineering science research. The leadership of KTH should consider career paths for skilled teachers and educational developers.

Gender balance (in particular vehicle programmes and at senior level)
About 30 % of junior teachers and PhD students are females. This is not reflected among more senior teachers. Measures have been taken to improve the balance, but they seem to be insufficient. The gender balance among students is also very poor for several programmes.

Recommendation
Increase the use of performance reviews for female teachers and PhD students to inspire them to continue their career at KTH. Review how the different programmes are promoted to attract more female students.

Illogical and unproductive split of disciplines between schools
The school structure sometimes creates illogical splits between different subjects, examples are the split of mathematics and numerical analysis, physics and materials and the 5-year programmes in vehicle engineering and mechanical engineering.

We have also noted school borders as obstacles to cooperation. In cases when cooperation works, this depends on good personal relations.

Recommendation
Review the division of disciplines between schools and give the rationale for the divisions.

Web pages
We have learned that it is very difficult to find information about programmes on the web pages. We found different information at different locations as well as different information on Swedish and English pages.

Recommendation
Fix them.

Feedback regarding the Master of Science in Engineering in Vehicle Engineering (CFATE), the Master of Science in Engineering Mechanics (TTEMM), the Master of Science in Aerospace Engineering (TAEEM), the Master of Science in Vehicle Engineering (TFORM) and the Master of Science in Naval Architecture (TMRSM) programmes

GENERAL IMPRESSION

The 5-year programme in vehicle engineering ("civilingenjörsprogram i farkostteknik") is well established with a solid reputation in industry. The employability is very good and stable. The programme is well organised and the teachers meet regularly in Kaizen meetings to discuss teaching and learning as well as course and programme development. The programme has a long-term reputation of educational and curriculum developments. In particular, the development and implementation of the CDIO approach, integration of general engineering skills, implementation of real-world engineering experiences and programme-level learning outcomes with connections to the courses through which the intended outcomes are achieved. The leadership is committed and ambitious. A large number of pedagogical and curriculum future developments are discussed and planned, but implementations seem to be slow.

The self-evaluation as well as the educational assessment was carried as a group consisting of the 5-year programme in vehicle engineering together with four 2-year master's programmes (aerospace engineering, engineering mechanics, naval architecture and vehicle engineering) that originate from specialisations within the 5-year programme and, thus, are closely related. However, the time for the interviews was too short for the panel to be able to critically review all programmes and follow up interesting issues identified in the self-evaluation report.

The 2-year Naval Architecture programme has fully adopted the CDIO approach and has a well-functioning quality circle based on Kaizen. Furthermore, the programme has a strong involvement with industry, which, e.g. is manifested in the annual 2-day conference where students' work is presented and educational matters are discussed. Industry and teaching staff, as well as bachelor and master's level students, attend the conference. Management and teachers regularly publish educational developments and attend conferences on engineering education research. The programme in naval architecture can serve as an example of how to include industry stakeholders in a master's programme.

The 2-year Aerospace Engineering programme is developed based on student feedback through course evaluations, occasional interviews and workshops. There is no formalised way to include industry and other outside stakeholders in the programme development work.

The 2-year Engineering Mechanics programme has no regular meetings with all teachers. Instead, a committee with selected teachers and track directors meet two/three times per semester to discuss the programme. Programme evaluation is focused on the performances of the students. The programme has no formalised way to get feedback from students, industry and stakeholders. The involvement from industry seems to be very weak.

The 2-year Vehicle Engineering programme is new. The programme is very broad and includes courses from different programmes and Schools at KTH. The programme quality and development work is carried out within a small group of teachers from the rail vehicle division. In the longer perspective, all teachers will be invited to the programme development process. The involvement from industry can be regarded as strong, since a many of the teachers have strong contacts with industry and have been working in industry. The programme focuses on railroad vehicles and transportation and the name may be somewhat misleading. Sustainability aspects of transportation are integrated but also taught in specific courses.

STRENGTHS AND WEAKNESSES

The 5-year programme has a high drop-out rate of approximately 50 % and above. The number of dropouts is higher compared with the average at KTH and compared with similar engineering programmes in Sweden. The rate is perhaps not as bad as it seems, due to the fact that many students start work having only a few courses left.

The students' results in year 1 are poor and in some years (2007 and 2008) very poor. The largest problem is the 1st year mathematics courses. In years 2007 and 2008 the mathematics courses were changed to become more difficult. The panel has learned that the students do not appreciate the mathematics courses, do not understand why they study maths and cannot see the links between the maths courses and the applied vehicle engineering courses.

The high number of dropouts and the poor results are explained by management to be the result of the students having a weak prior knowledge in mathematics and being less motivated, less ambitious and having a different attitude compared with those of about 10 years ago.

The panel can understand that the prior knowledge in mathematics is difficult, but we do not agree in the analysis that the students are less motivated and less ambitious. The programme is popular and the number of applicants is high. This means that there is a positive selection of students. It is definitely not the picture conveyed by the students. It is also hard to believe that there should be a significant difference between students in the 5-year engineering physics programme when it comes to motivation and ambition. Naturally, the students' interest, prior knowledge and learning styles change over the years, and this must penetrate to the programme development process. The panel has learned from the students that there is a mismatch in the students' expectation of the programme and the 1st year courses. The students have expected the programme to be more applied and less theoretical.

The students are generally more interested in the vehicle engineering applications than in the core fundamentals. Despite the CDIO approach with a focus on real-world problems, the students have difficulties in seeing the links between the fundamental courses in year 1 and the more applied later courses. However, the graduates are, in general, very satisfied with the structure of the programme as well as the fundamental and more applied parts of the programme. Although, a minority of the students regard the first 3 years to be more theoretical than required.

The number of students on the master's programmes is generally low. This is compensated by joining students who only take some courses or a part of the programme. The number of students on the courses seems to be fine.

The number of students graduating from engineering mechanics is surprisingly low. However, this seems to have been improved as more students have entered the programme.

The gender balance is poor at bachelor level and very poor at master's level. There are classes with no female students. Measures have been taken, but they seem to be insufficient. The female students in the 5-year programme perform well and are satisfied with the programme.

The CDIO approach is beneficial for the programmes. The tools for programme development and integration of general skills are well known and put in practice. The acceptance for CDIO is high, although the panel experienced a trade-off discussion between CDIO and the theoretical fundamental courses.

The panel believe that there should be no trade-off. Putting fundamentals into a context and applying them in the treatment of real-world problems should be beneficial and motivate the students to study.

The CDIO approach, together with the strong procedure for evaluation and the high involvement of teachers in the programmes, is useful and a potential platform for quality assurance and programme development. Kaizen is good in year 1 through to year 3, but not at master's level, when the meetings tend to be more informal. In the self-evaluation report there are many examples of pedagogical and curriculum developments. Some have been implemented, but when it comes to mathematics and sustainability there is little evidence of any implementation. The plans presented for the development of the mathematics and sustainability education are good and necessary for the 5-year programme to be able to maintain its position as one of the leading programmes in Sweden.

The panel has understood that the programme management has very limited control of course delivery, particularly for courses from departments outside the SCI school. This, of course, limits the opportunities to implement developments.

To improve the quality of the master's theses has been put on the agenda. There is a lot of promising ongoing work in all programmes. Unfortunately, only one degree report was sent to the panel. This degree report was written in Swedish and the task was not representative for the programme in vehicle engineering. The report was well written, but the scientific as well as the engineering quality were questionable. The task was not appropriate for a final degree project in vehicle engineering. From a list of degree reports and from the interviews, the panel have learned that a rather high number of final degree reports are written in Swedish (it varied between the different master's programmes). This is not appropriate at master's level, with a mix of nationalities, and it is remarkable in view of the fact that skills in English are highlighted, trained and assessed in years 4 and 5 according to the self-evaluation report.

The split of the 5-year programmes in mechanical engineering and vehicle engineering between different schools is cumbersome, as the programmes have a lot in common, e.g. courses in maths, mechanics and product development as well as several specialisations. A closer cooperation between the programmes is potentially mutually beneficial. It also seems that the students of vehicle engineering have more in common with the students of mechanical engineering than the students of engineering physics.

The lack of a basic course in engineering materials in the 5-year programme is cumbersome. New materials and an efficient use of materials will be critical for the vehicle industry, in particular, in view of sustainability.

RECOMMENDATIONS

Continue to develop the CDIO approach and include all programmes and courses.

Reform the mathematics education in the 5-year programme. Put applications from vehicle engineering in the courses and integrate numerical and traditional analyses. Consider having some "just-in-time" teaching of mathematics, i.e. teaching of mathematics in courses where it is needed, e.g. fluid mechanics and control theory.

Put more applications in the beginning of the 5-year programme and implement more design-build experiences.

Work together with the students to align the expectations of the 5-year programme. Place special efforts on reviewing how the programmes are promoted to attract more female students.

Consider developing and implementing a basic course on engineering materials in the 5-year programme.

Implement quality assurance systems at all programmes.

Involve industry at all master's programmes. The programme in naval architecture can act as role model of this.

Put sustainability on the agenda and implement the teaching of sustainability in all programmes.

Use English at master's level.

Extend the cooperation with the 5-year programme in mechanical engineering.

Work more intensively in marketing the 2-year master's programme. Include industry in this.

Feedback regarding the Master of Science in Engineering and of Education (CLGYM) programme

STRENGTHS AND WEAKNESSES

The quality assurance is well organised in an efficient manner, both at course level and at programme level. There are, for example, annual meetings where quality assurance is discussed. In these meetings, the programme management meets with student representatives and teachers responsible for courses. Also, the programme graduates are consulted after one year of graduation on the suitability of training programme. This programme, being a double degree programme, has a special character, thus in the quality assurance meetings all sort of issues are discussed, from to schedule question to individual student problems. Not all teachers take part in all meetings and, therefore, teachers find these arrangements valuable. Students say that they can also have an effect on the contents of single courses. Thus, these arrangements are relevant.

The programme's master's degree project has its own course plan which means that the organisation and the learning differ from the other engineering programmes. A broad competence helps to ensure that projects qualify for both engineering and teaching degrees. Supervision and examination is carried out by one of many departments at KTH or Stockholm University. Most degree projects are carried out in an external environment (company or a learning institution), addressing problems originating from this external agent.

The scientific level of the teaching staff is adequate and the gender distribution of students is good. Contacts with current school practices and other pedagogic environments are extensive.

The mathematical background differs substantially between 1st year students; therefore, measures have been taken, for example Supplemental Instruction (SI) in mathematics has been organised. Evaluations of examination results show that students taking part in SI perform better. Moreover, less successful students in mathematics courses are invited to dedicated problem-solving groups that will prepare them for the re-exam. All of this is organised by older students – which is good practice. Moreover, a basic mathematics course covering the gap between upper secondary school maths and university maths is given during the first three weeks by teachers.

The programme's strategy is to combine standard courses from the engineering programmes with courses for the teaching in upper secondary school. Courses in mathematics and several cross-disciplinary courses at KTH have been developed especially for the programme, with the requirements on teacher training programmes in the Higher Education Ordinance.

The programme graduates are mostly employed in their field of specialisation. Employers are satisfied with the programme graduates. Graduate students are satisfied with the education they received in the programme, even if many of the students the evaluation panel meet said that they would not choose the programme again. The main reason seemed to be that they had realised they did not want to work as teachers after graduation.

It is easy to enter the programme compared with other KTH programmes, and that is probably the reason why drop-out rates are high. Since its starting year, 2002, 442 students have been accepted to the 1st year of the programme. Approximately 200 students have interrupted their studies; of these, 65 % left during either of the two 1st semesters.

When the programme management was asked about this matter, their response was that this is a national policy level issue, as only 1/3 of the students can be selected by the CL management, the rest 2/3 cannot.

However, the university leadership did not confirm this claim, in fact the CL programme, being part of the SCI school, could choose its students.

Contact with current research in the educational sciences is said to be at an adequate level and students of the programme are said to benefit from research development in pedagogical courses given by Stockholm University. However, when asked during the site visit, the teachers could not give any examples. Also, the interviewed students told us that there is not much of this. We conclude that the claim is not supported and contact with current research in the educational sciences should be improved.

A direct evaluation of how students meet the learning outcomes of the programme is lacking, except for an alumni questionnaire. There is no plan to improve the situation.

Many of the courses are not tailored to students studying in this programme: courses in physics, chemistry and computer science are compulsory courses on other engineering programmes. Teachers regard this as a problem as the pedagogical aspect should also be included. The evaluation panel agrees with the teachers' opinion. However, according to the programme management, non-tailored courses are not a problem.

Oral presentation, scientific writing, teamwork and IT skills are currently not in at a satisfactory level; however, it is claimed that in the new 2011 CL programme this difficulty is improved. The evaluation panel agrees with this opinion.

Teachers' pedagogical competence and efforts are not properly valued. This can be seen, for example, in recruitment procedures. Pedagogic development relies on efforts of individuals and their personal initiatives rather than on forces inherent in the system.

The learning outcomes of the degree project demand that each degree project should connect to an advanced knowledge in mathematics, science or technology. Far from all projects fulfil this ambition. However, the learning outcomes of a given independent project work "Cliffordalgebra för gymnasieelever" reached the objectives set out.

Overlapping courses at KTH and Stockholm University and the tightness of the time schedule of the programme gives little extra time leftover for personal study. Programme logistics are complex. The programme requires a comparatively large management, due to its complex logistics and broad range of subjects. Students commute between two campuses.

RECOMMENDATIONS

The proportion of dropouts must be reduced. Since the CL programme can choose its students and the 1/3 rule is not compulsory in the SCI school, the CL programme should consider a separate entrance test. This would guarantee motivated students and reduce the number of dropouts.

The overall feeling of CL students is good and the students are very social and stay together; however, the general image of a CL student among the other KTH students is strange. They consider CL students as just future teachers, not engineers. Thus, improvements by good examples are needed. And more generally, outside KTH little is known about the CL programme, even though it is the largest in its field. To improve the reputation of the CL programme, KTH should highlight the students who have already graduated.

Each CL student has a VFU teacher contact/mentor at a high school. Feedback from these teachers into the programme, both at individual and at programme level, should be given more room.

At present, students commute between two campuses, instead of teachers. Consider centralising pedagogical studies to a certain period without studies in KTH and try to reduce bureaucracy or make the teachers commute instead.

Feedback regarding the Master of Science in Engineering in Engineering Physics (CTFYS) programme

GENERAL IMPRESSION

The programme, which has good connections with industry, has been well established over many years and today has a strong leadership that is committed to continuous improvements through quality circle programmes like Kaizen and CDIO. It is encouraging to observe that the CDIO approach is implemented in a programme that is known to be theoretical. The panel has learned that the programme management has a very constructive approach for the implementation and integration of CDIO skills. This has resulted in reformed courses (e.g. Thermodynamics), links between courses and new engineering courses (e.g. Fluid mechanics).

The self-evaluation process and report are examples of best practices involving students, faculties and industry stakeholders.

STRENGTHS AND WEAKNESSES

"Civilingenjör teknisk fysik" is a well-known "brand" and is generally recognised, not least by employers, as a very challenging programme with a broad technical content that exclusively attracts top students. Industry employers are thus aware of the fact that students who have successfully passed the programme could be put on tasks at the highest possible technical levels but where a perfect subject match is not required. This fact may, however, limit the employment opportunities to the larger industrial corporations, as they are the main suppliers of these kinds of jobs. Among employers there is also an awareness of the backlash from hiring over-qualified people who will soon look for better opportunities. Not surprisingly, in this perspective, one third of the students will continue with PhD studies. More surprisingly is the fact that as many as one third of the students specialise in financial mathematics. The interest in specialising in engineering mechanics is particularly low.

With this high-programme profile it is only natural that students with the very highest degrees are admitted, but at the same time it is very surprising to find a very high dropout rate of approximately 50 %, which is on a par with other programmes at KTH. In the self-evaluation report, which certainly reflects the fact that the programme management has taken the self-evaluation task seriously, this is analysed in detail, since this high rate is the main weakness found in the programme.

One important reason behind this high rate is the actual attractiveness of the programme, where top students enter the programme as their second choice, e.g. with medical education as the first, and then very soon find out that the efforts needed for mastering mathematics is not what they had anticipated and will therefore enter other programmes as soon as possible but with one year "lost" for both parties. To reduce this risk a mathematics and physics admission test is suggested, where potential dropout candidates of this kind can be identified and perhaps also be discouraged from really getting into the programme and enable other candidates, more inclined towards mathematics and physics but not necessarily with the highest grades in other subjects, to enter the programme. This kind of test has, however, been used at Chalmers and did not prove successful in achieving this goal.

Another major reason for the high dropout rate is the fact that students in their final year may be offered jobs without a formal diploma and with little later impetus to do whatever is still required to actually graduate. Here there are no obvious remedies other than a closer monitoring of the progress of each student and paying special attention to those students who have been very closely examined for some years.

For the evaluation panel, it is evident that the programme management struggle with the 1st year dropouts by increasing the motivation of the students to put the necessary hard work into their theoretical studies. Innovative procedures to connect the theoretical content with the "real world" are recognised as essential. Efforts in the course of thermodynamics are here noteworthy, where the students are forced to do practical outdoor activities in groups of two in order to grasp "what it is to be a physicist". Not surprisingly, the teacher here was chosen "Best teacher of the year at KTH".

The teaching staff is very involved in the running and development of the programme. Interviews confirm this picture. Moreover, the teachers showed a very constructive engagement in the CDIO approach and saw only opportunities in the integration of general engineering skills and the transfer to a more engineering-based programme.

From the interview with the students, we learned that the students are very satisfied with their education and the opportunities of being engaged in the running of the programme. The claimed (and gave examples) that their feedback was taken seriously even though implementing any action could take some time.

The gender balance is not good, especially among the teaching staff. Measures have been taken at KTH but it does not seem to have improved the situation. The gender balance among students is better: 20–30 % female students, but it is still not good. Measures have been taken. The panel has learned that the female students' satisfaction level is high, their results are good and that they are more involved in the programme than male students.

Course evaluations vary in quality and more with the teacher than with the department. When the evaluation is taken seriously and is course specific it is much better than the web-based standard evaluation. Mid-course evaluations are carried out only in comprehensive courses, like the one on general physics.

RECOMMENDATIONS

Introduce admission tests in maths and physics to get admitted to the programme, but use experiences from similar tests at other universities when developing it.

Formulate and put into practice clear rules for advancement to 2nd and 3rd year as well as to be admitted at master's level.

Develop the maths education to include real problems and the full view of problem-solving. The course in thermodynamics can be taken as a role model for this.

Extend the CDIO approach to permeate the whole programme, including finalising master's programmes.
Include industry stakeholders in the long-term development and quality assurance of the programme.

One possible way to do this is to include people from the industry in the so called F-council or through a F-industry–council, as discussed in the self-evaluation report.

Include substantial sustainability in the curriculum, see general recommendations.

Examine the reasons why such a high proportion of students are opting out of applied physics and engineering mechanics at master's level.

Feedback regarding the Master of Science in Mathematics (TMTHM) programme

GENERAL IMPRESSION

The self-evaluation report gives little indication of how the master's programme is managed, how changes are made and how quality is assessed. The programme management clearly has put very little effort into explaining what procedures are followed to maintain or improve the quality. In particular, it is not clear how the decisions in the programme are made and how changes come about, except a reference to informal discussions in the department.

Learning outcomes are listed for some compulsory courses, but no indication is given on how they are achieved.

The assessment panel met the director, responsible people from three out of five specialisations and two students who graduated from one of the specialisations at least one year ago. Thus, the programme was not well presented, neither at teacher level nor at student level.

STRENGTHS AND WEAKNESSES

The programme has a highly qualified research staff, and several members of the faculty have received pedagogical prizes and awards such as "Årets lärare" (teacher of the year).

The individual project report that the panel read is very good and certainly reflects strengths in the programme. The candidates apparently get good jobs, although an overall view of this is lacking.

The mode of management of the programme is very informal with quite unclear processes, especially at programme level. The specialisations each have a responsibility, and the management of these varies. In at least one case it is formalised with regular procedures.

The list of courses offered changes continuously, this is decided within groups in the departments and not in the programme. A regular scheduling procedure for the courses in the programme is not in place.

A regular discussion and procedure to decide which courses the master's programme should offer and which it should require is not in place.

Evaluation of many master's courses is lacking. There is no common approach to course evaluation, leaving it completely up to each course responsible.

There is an apparent lack of systematic discussion of courses and of teaching practices, resulting in a large variation in teaching quality.

The learning outcomes regarding communication skills, oral and written, and teamwork skills are assessed in various courses and in the final thesis. There is no assurance or guarantee that every student gets training in these skills beyond the final thesis work.

The lack of formal structure and organisation is a risk for the quality of the programme. In particular, since the programme has so many and diverging specialisations.

The compulsory courses in the master's programme are normal undergraduate university courses.

With the mixture of KTH and foreign students entering the programme, the student background varies a lot, and this is a challenge in the master's curriculum development.

RECOMMENDATIONS

The management of the master's programme should be strengthened.

Formal procedures should be introduced to get more teachers and students directly engaged in the development of the courses and the programme.

Measures should be taken to share and discuss best practice in teaching. The use of quality circles in other programmes has worked for this purpose, and can be copied.

The programme's web pages should give more detailed information on both the programme structure and on the courses.

For an international master's programme in mathematics one should not give credit to normal undergraduate university courses, so the list of compulsory courses for this master's programme should be reconsidered.

If an undergraduate course is necessary it should be required to enter the programme.

Feedback regarding the Master of Science in Nuclear Energy Engineering (TNEEM) and the Master of Science in Engineering Physics (TTFYM) programmes

STRENGTHS

- *Study plans*. Use of study plans for international students in which each student submits a study plan to the TTFYM programme director for discussion and approval. However, Swedish students select courses on the web which are not necessarily reviewed in detail.
- The use of *track guides* in TTFYM, who are experts in their particular track areas is positive and offers informed advice on module selection, among other things. Students see these posts as helpful mechanisms for providing feedback
- Teaching staff. The panel met with motivated and enthusiastic teaching staff who were:
  - passionate about their own subject area.
  - taking advantage of Learning Lab opportunities.
  - able to give good examples of curriculum improvement through twice annual staff meetings.
- *Group work*. Good examples of group work on both TNEEM and some of the TTFYM tracks.
- *Sustainability at course level*. Good examples of sustainability education in courses provided by teaching staff from the TNEEM programme.
- *Cohort allegiance*. Students on the TNEEM programme, in particular, feel a strong allegiance to the programme.
- *Overall student satisfaction*. All the students we met would do the same programme again if they were to have the same choice again.

WEAKNESSES

- Student feedback. While the related 5-year programmes have well-established mechanisms for gaining student feedback in years 1–3, the approach at master's level is haphazard.
- Programme managers emphasised meetings with staff and course evaluation but could describe no mechanism other than informal talks for obtaining feedback on the programmes as a whole.
- Students on the TTFYM programme mentioned the track guides as a useful point of contact, but the onus is on the student to raise issues, which may be a particular issue for some international students.
- The TTFYM coordinator stated that meetings for the full cohort might be a problem due to the many tracks – this needs to be taken into account but should not be an excuse to do nothing.
- Teacher participation. Teachers on the TTFYM programme were unaware of any forum in which they could take part in a discussion relating specifically to the programme. Teachers on TNEEM are invited to twice-yearly programme meetings.
- Programming skills. Both staff and students reported a problem that some students have with the computer coding skills required on TNEEM. The coordinator stated he did not see training in coding as a part of the programme, yet an action from a 2008 review is quoted in the self-evaluation report: "Introduction to Monte Carlo methods and MATLAB is needed." When asked specifically about this, the coordinator stated that this was still in preparation
- Induction activities. The self-evaluation states: "the international students sometimes encounter difficulties ... One such difficulty is ... little experience of problem-oriented teaching/learning and laboratory. Also, ... [they are] often unfamiliar with our examination system. We try to prepare ... during the introduction programme at KTH. We also provide mentorship." The following comments from the students suggest that these activities are insufficient:
- Nuclear students have no induction – "come here – courses start."
- "Possibly an hour meeting."

- "Had no clue what an exam would be like."
- "Don't understand the grade system or how the exam system works."
- Students also felt this compared poorly with a full week-long induction that is offered to ERASMUS students.
- Sustainability at programme level. Neither programme director was able to provide examples or overview of the delivery of sustainability education from their programmes. While discussion with the teachers suggested there is good practice in some courses, it does not appear to have been planned in a coherent way across the programme.

RECOMMENDATIONS

- Implement clear mechanisms for obtaining and acting upon feedback from students, perhaps building on the track guide model in TTFYM.
- Ensure that there is a forum for teachers on the TTFYM programme to contribute to the development of the programme as a whole.
- Ensure agreed actions from the 2008 review are implemented in full, particularly with regard to coding and Monte Carlo work.
- See general recommendations regarding sustainability.
- While the strong emphasis on group work in the TNEEM programme is commendable, there is clearly discontent among some who feel that there are "...people who get dragged along with groups and do nothing". Students said there was a particular issue with ERASMUS students who have to gain credits, but do not benefit from high marks. While there is no simple answer to this problem, the programme director should ensure these issues are discussed regularly with the students as part of any new feedback process.

Feedback to KTH management

RECOMMENDATIONS

See general comments regarding organisation responsibility structure and practice, trade-off between research and education, allocation of resources, quality assurance at programme level, sustainability, Swedish at master's level, maths education and split of disciplines between schools.

STRATEGIC DECISIONS

Put substantial resources and responsibilities to include sustainability into the educational programmes and to reform the mathematical education.

Feedback regarding the EAE methodology

GENERAL IMPRESSION

Our impression is that the education assessment is very ambitious. The programme at KTH was very well organised and valuable.

Interviews with the programme management were too short, particularly when several programme management groups were interviewed at the same time.

The quality as well as the style of the self-evaluations reports varied a lot, from high quality to not very helpful at all. It was obvious that some groups had pre-training before the interviews while others had not.

It was difficult to find in-depth information about the programmes and courses before the meeting. In particular, we missed the programme descriptions.

We were given too few degree reports to be able to judge the quality of the programmes and two of the reports were written in Swedish, which was inappropriate. The themes of the degree projects were widely distributed and we felt that only a few reports reflected the characteristics of the programmes from which the reports originated.

RECOMMENDATIONS

We suggest quality assurance of the process and proofreading of reports to improve and facilitate the assessment.

Prepare background materials (e.g. programme and course descriptions) on a website.Increase the number of degree reports or select reports that reflect the programmes.

Make sure that the interviewees are well prepared and that the programmes have picked current students (not former students) in the student interview section.

Technology and Health Sub-panel report

Anna-Lisa Osvalder (Chairperson), Chalmers University of Technology
Jonna Holmgren, Uppsala University (student representative)
Peter Munkebo Hussmann, Technical University of Denmark
Werner Osterhaus, Aarhus University
Jos Vander Sloten, Katholieke Universiteit Leuven

Feedback to the self-evaluation groups and school management

STRENGTHS

- Large potential for the STH School, i.e. the idea of integrating technology with health aspects, medicine, work environment and overall well-being is winning. It is also a potential for the discussion of sustainability in programmes/courses – the sustainable human being.
- Dedication of most teachers to education (for example, some have attended teaching courses at KTH Learning Lab and implemented it). Most teachers involved in the programmes mostly teach and do not work with research activities to a great extent, teaching is the main focus.
- Non-traditional programmes are given instead, for example, very interesting programmes related to the human, i.e. more uncommon and unique programmes (e.g. the lighting programmes), which might attract students from all over Sweden and abroad (master's level).

RECOMMENDATIONS

- Explore further integration/interaction/synergy between school programmes and teachers and also to the theme "technology and health". A deeper integration between the programmes is possible:
  - master's in architecture and lighting and master's in ergonomics and master's in health and work.
  - within the medical technology programmes (master's and bachelor).
  - improve coherence and cooperation among teachers in the individual programmes (as in the computer science programmes, use as an example of good practice).
  - use CDIO (conceive, design, implement, operate) principles when reviewing and revising programme and course goals and learning objectives, and also discuss the sustainability theme.
- The school management mentioned that the students are not as involved educational development as they used to be. They answer the evaluations but are not represented at the next level as they ought to be. The students' chances to influence programme development been reduced. This is something that we feel KTH should look into and see if there is anything that can make the situation better for the students. The student view is important in order to achieve continuous improvement throughout the school and programmes.

Feedback regarding the Master of Science in Engineering in Medical Engineering (CMEDT), the Master of Science in Medical Engineering (TMLEM) and the Bachelor of Science in Engineering in Medical Technology (TIMEL) programmes

STRENGTHS

The programmes enjoy the strong personality and the dedication of the programme director. He has co-ordinated the development of both the 3-year and the 5-year programme. This also explains why little time could be spent on the preparation of the self-evaluation report, which has been written mainly by the programme director, based upon discussions with the other stakeholders (teaching staff, students, administrative staff).

All parties state that good and clear information is provided to students, thanks to the availability of a student administrator who is also very dedicated and appreciated by the students.

Student satisfaction regarding availability of teachers is high, although students comment that contacts are mainly carried out via e-mail because of the different locations where the programme is organised. This has of course consequences for the face-to-face availability of teachers since they are bound to their location. E-mail contact is however not considered to be a problem, provided responses are swift and complete.

The protocol for course evaluation and follow-up is clear to all parties involved and is operational to the satisfaction of all parties.

KTH offers two different orientations related to medical technology: one professional 3-year bachelor programme which is industry-oriented and one academic 5-year master programme which is oriented towards R&D (both in industry

and in universities). The complementarity of both programmes is clear in their objectives and in the way courses are delivered to the students (although this is clear in principle, it will be mentioned under the item "weaknesses" that the different approaches in the bachelor's programme and in the master's programme are sometimes not clear in practice). The 3-year bachelor's programme responds to a proven need from local industry as does the 5-year master's programme.

WEAKNESSES

Whilst it is mentioned that the strong personality of the programme director is an asset for both the bachelor's and the master's programme in medical technology, it can be considered to be a weakness at the same time that responsibilities are concentrated to one person only.

Although it is claimed by the programme directorship that teachers who teach similar courses in the 3-year bachelor's programme and in the 5-year master's programme implement different approaches to teaching and examining these courses, this is not confirmed nor explained clearly by the teaching staff.

The Swedish languages skills and grades of some foreign students are below average and this compromises team work in cases where teams of Swedish students and foreign students are put together.

The two programmes (3-year bachelor and 5-year master) also translate into different student profiles and this has proven to make it difficult to achieve a true integration of the two groups of students.

RECOMMENDATIONS

The main recommendation is to reinforce the integration between the three partners (KTH Vallhallavägen, Flemingsberg and Karolinska Institute). Particular attention should be paid to the integration to Karolinska Institute. This applies to access to libraries, computer system, and dealing with multiple electronic learning systems for different institutions.

There is also a need for more formal staff meetings to coordinate the programme and to decide upon responsibilities.

The coherence of the course content has to be monitored carefully, e.g. the basic mathematics course is not specific to the medical technology programme and this is not ideal to motivate students to study this course since they may not see the relevance of the mathematics course for the area of medical technology (the inclusion of examples and exercises where biomedical engineering problems are addressed can solve this problem).

A further issue of concern is the organisation of the medical technology programmes on different campus locations. Mobility is expected mainly from the students in this scenario, rather than from the teachers. Concentration on one location should be considered (see also next point).

Several stakeholders and especially the teachers ask for a concentration of more lab facilities and teaching facilities in the hospital.

The medical technology programme management teams are encouraged to collaborate where possible with other programmes e.g. ergonomics for user interface design and product development. These are also essential elements in the area of medical device technology or biomedical engineering, and interfacing to the clinical user of medical devices is of primary importance.

There is mainly an inflow of local students, although the programme has enough potential to attract students from other regions in Sweden, and even students from abroad. A prerequisite is a clear identity of the medical technology programme at KTH. The programme (five year master) should also position itself clearly against new programmes at two other Swedish universities (Lund and Linköping) that are considered to be threats to the KTH medical technology programmes.

Students who express an interest in entrepreneurship are directed to courses on management and leadership, but this should be made more explicit e.g. by providing a consistent set of courses (package) on this topic.

The establishment of an alumni association for medical technology graduates should be stimulated by the School of Technology and Health. This offers excellent networking possibilities, not only amongst the KTH graduates, but also with the teaching staff. It may reinforce the links between the medical technology programmes at KTH and the industrial stakeholders.

Feedback regarding the Master of Science (1 year) in Work and Health (TAHOM) and the Master of Science (1 year) in Ergonomics and Human-Technology-Organisation (TERGM) programmes

The TAOHM programme starts autumn 2011, so its results could not be evaluated.

A number of courses are given during one year in the programme TERGM at three different university sites: KTH, Linköping and Jönköping. One teacher at each site is responsible/the examiner for a few courses during the programme. The students travel to the different sites during the year. The average age of the students is 40–50 years, and they often have working life experience in engineering, physiotherapy, social science or psychology.

STRENGTHS

- The new programme (TAOHM) seems to respond to a documented need from society and industry.
- Formative evaluation (questionnaires, open discussions etc.) of courses (and during a course) in the TERGM programme (ongoing in-process improvements).
- Blended and differentiated learning environment in both programmes.
- Informal crossover learning between students with different backgrounds (useful in group work and discussions and in opposition of thesis work).
- The course meetings result in large opportunities for the students to socialise, network and discuss course matters, since the students stay overnight in the city during some days and have dinner together etc.
- The teachers/examiners available for questions and discussions when a course meeting is given during a few days at a site, in-between meetings teachers are available by e-mail.
- Completing the programme has a positive impact on job opportunities and career perspectives, it is also a base for PhD students in the area of Ergonomics.
- The students have a great interest in the programme and they enrol on the courses for their own interest or career opportunities (high motivation of students).
- The alumni association works well and is useful for networking and sharing information regarding ergonomic activities in Sweden. The alumni association has regular meetings/seminars once or twice a year where all previous students are invited, along with teachers and programme management.

WEAKNESSES AND RECOMMENDATIONS

- The Human –Technology – Organisation (in Swedish: MTO) theme is not fully integrated in the programme in all courses and is not fully explained to the students in the separate courses. The programme management/ examiners had a clear idea of incorporating and clarifying this theme in all courses, but the other teachers involved in separate courses and guest lecturers were not aware of this.
- There is some overlap between teachers (especially by guest lectures), which was noticed by students. This is a problem when many people are involved in the teaching activities in a course/programme. Improve communication between teachers in a specific course and between examiners for the courses in the programme. More formal meetings needed between all teachers involved in the programme (ideally twice a year).
- Students sometimes have problems finishing courses in time due to work, social, family situations etc. The thesis work takes too much time to finish, and some students do not pass the whole programme (approximately 50 % finish the programme). One reason for this is that the students do not need the higher education credit points for their future careers, only the knowledge gained in the courses. Management needs to work even harder to contact students and convince them to fulfil their programme obligations.
- Students had limited access to relevant and updated literature (especially in medicine, problem with asses to literature at KI, access to, e.g. Medline needed), old references and handouts are sometimes used. The students also need better recommendations from the teachers/examiners of relevant books and scientific articles etc., especially for their thesis work and projects in the different courses. An ergonomics library has been asked for, and maybe this could be located at the School of Technology and Health, but one would also be needed at other sites.
- Lack of statistical support if needed for the degree project – a statistical help desk could be created. A responsible person at the School of Technology and Health is needed who is also skilled in statistics for the types of studies which are performed in the area of ergonomics (human test subjects, subjective data, qualitative data analysis). This person should also be skilled in how to use the computer programs, and available for the students between meetings to some extent. Idea: include a separate course day working with a statistical computer program in class with a skilled supervisor. Overcome the problems with implementing and using the statistics computer program (SSPP). Student licences needed.
- Teachers are only available at course meetings, sometimes there is a problem in obtaining contact with teachers between meetings or after a course is finished, only e-mail or phone contact is possible. However, it sometimes takes time to get an answer and receive

feedback. The examiners from the different sites do not work closely every day, which could sometimes be a communication problem regarding programme planning and other small practical issues. However, on the other hand, the examiners know each other well, since they have been working together in Linköping earlier.

- The depth of course content does not yet appear to correspond to a master's-level requirements, but this seems to be the aim of the programme, more on the bachelor level in the area of ergonomics. Due to the different background of students, the depth in theory and methods does not suit students who have basic knowledge (bachelor level) in, e.g. cognitive psychology, social psychology and organisation, biomechanics, anatomy/physiology, product development and work environment issues such as noise/vibrations/lighting/climate.
- A strong opportunity to have a stronger integration between lighting design and ergonomics courses and research. Opportunities to share teachers, course material, projects etc., and discuss environmental lighting issues from different point of views. Also, integration with the medical technology programme regarding, e.g. user interface issues and usability design.
- Students miss a course, or part of course where psychosocial factors and stress are discussed.
- Actions should be taken to link the learning outcomes at course level better to the programme objectives (cf. SWOT analysis). CDIO (conceive, design, implement, and operate) principles can be a great help when reviewing and revising course goals and learning objectives.
- The theme of sustainability should be implemented to some degree in all courses and projects, and be specifically mentioned in each course curriculum.

Feedback regarding the Bachelor of Science in Engineering in Computer Engineering (TIDAA) programme

The Bachelor of Science in Engineering (högskoleingenjörsexamen) in Computer Engineering seems to be the most coherent and well-functioning programme in the school of Technology and Health at KTH.

STRENGTHS

The programme management seems to have a good overview of the programme and it works continuously and systematically to enhance the programme with regard to coherence and progression, alignment with industry needs and student prerequisites. The programme management and the staff members have been working with the KTH Learning Lab in order to map the national programme outcomes to the local learning outcome. The learning outcome matrix is a result of this work and, at the same time, a tool that will be used for the ongoing development of the programme.

There seems to be a very good ongoing interaction between the staff members. Teachers are strong collaborators (team players) who are very much engaged in the whole programme. They meet regularly, both formally and informally, to discuss their teaching and the programme as a whole. The teachers also co-teach in the courses, and this gives them all a very good understanding of all the courses and the relationships between the courses. It must be noted that the colocation of staff members, labs etc., might have a positive effect on this – in contrast with most of the other programmes in the school.

The teachers and management seem to be very responsive to student needs and the students have a lot of influence on the ongoing development of the programme. The students have been heard and involved in relation to the redesign of the programme. Identified problems seem to have been addressed appropriately (e.g. the specific course delivered by staff outside the programme (Environmental Science and Work Science) seems to have been addressed effectively).

The students emphasise the good and close contact with the teachers who seem to be available to the students almost all of the time. Furthermore, the students emphasise the good mixture of theory and practice in the programme as well as the good interaction with industry.

The maths course is integrated in the programme and the maths teacher is part of the teaching staff at the school and participates in the teacher meetings.

This makes it possible to make the maths course more relevant for the students. This is in contrast with most of the other programmes in the school, where maths courses are given by other schools/departments resulting in poor integration in the programme.

WEAKNESSES

It is a major problem that many students leave the programme to work in industry before graduation, and hence never finish the programme. It seems to be a short-sighted solution which serves neither the students nor the industry in the long run. Therefore, it is recommended that the programme management take action to prevent this from happening. One way forward could be to enforce that all courses should be passed

before engaging in thesis work.

It is also recommended to consider a revision of the courses that are typically not passed by the students (e.g. the maths course). Since the students are able to pass later courses without having passed the maths course and other basic courses, there might be a problem with the content and/or the scope of these courses.

The programme management emphasise the perceived lack of practising engineers as teachers. This problem is described as an academisation of the teachers' competences. However, people with experience from industry are needed. We endorse this problem and recommend that KTH management takes action in order to ensure a more diverse composition of staff, among other things, by encouraging other kinds of employment (e.g. part time at university and part time in industry). As in most other universities, research attracts the most focus from KTH management while education and teaching seems to be under prioritised. Different measures to promote and reward teaching should to be put into practice.

Despite the ongoing work of the programme management and the other staff members to ensure coherence and progression in the programme, students would like an even clearer "red thread" throughout the programme. We know that this is the case in most programmes; however, it could be considered to accommodate the students by illustrating this to students even more by giving examples and by integrating courses even further in project work.

RECOMMENDATIONS

It seems possible and relevant to increase the focus on health technology in the Computer Engineering programme among other things, to attract more female students and teachers. Invite more practising engineers from industry as guest lectures.

The CDIO that seems to have been launched by KTH management as a common tool for curricular planning and outcome-based assessment at KTH has not been explored or applied at the school or in the programme. A commitment to the CDIO approach could strengthen the curriculum development even further. However, it seems necessary that KTH management should provide the organisation with more information and help the schools and programmes with the application of CDIO. The same goes for sustainability aspects, which seem to be underdeveloped in the Computer Engineering programme.

Feedback regarding the Master of Science (1 year) in Architectural Lighting Design (TLODM) and the Master of Science (1 year) in Architectural Lighting Design and Health (TLDHM) programmes

STRENGTHS

While several universities in Scandinavia offer individual courses in lighting design and/or technology, the architectural lighting design programmes at KTH in Haninge are currently the only programmes in Scandinavia which allow students to gain a degree in architectural lighting design.

The programmes are well known around the world and attract students from many countries. Students enrolled in the programmes came from 28 nationalities in 2010 and 20 nationalities in 2011. Students also come from a variety of backgrounds, with architecture, urban design, interior design, industrial design and electrical engineering being the most common. Both staff and students describe these diverse experiences as a valuable asset for the programmes. Students are selected on the basis of their previous academic performance, their motivation letter and the letter of recommendation from an academic or professional.

Students value the close relationships with the teaching staff and the family-like atmosphere created in the programmes. Graduates seem to have no difficulties gaining employment in their chosen field, and some have started their own lighting design company. Alumni regularly meet at lighting conferences and many maintain contact with KTH staff throughout their professional careers.

The programme's director, Jan Ejhed, has received international recognition from the Professional Lighting Design Association (PLDA) in 2009 for his long-standing commitment to lighting design education and research (see Professional Lighting Design, No. 69, Nov/Dec 2009, p. 52). In addition to starting the current lighting design education at KTH and working hard to establish the PhD programme there, Jan has international impact through his professional lighting design work and research contributions within PLDA, as well as within the International Commission on Illumination (CIE), where he was, until this year, Director of Division 3: Interior Environment and Lighting Design.

His professional connections at international level allow the programmes to bring a great mix of visitors from around the world to Stockholm. Through their expertise and experience, these visitors contribute to the richness of the lighting design education at KTH.

KTH has recently been successful in attracting funding for three PhD students in lighting design (from Kurdistan, Portugal and Italy). These first students are in their starting phase right now, and it is expected that additional PhD projects will be added over the coming years.

WEAKNESSES

Despite the obvious attractiveness of the architectural lighting design programmes and their reputation, we had difficulties understanding the programme objectives and course contents in their full extent. There are conflicting descriptions on the website and courses are also listed with different names (e.g. "Daylight and Architecture" in the programme outline and "Daylight and Design Process" in the course and programme directory).

Especially for the 2-year Architectural Lighting Design and Health degree programme, there is insufficient evidence in the programme outline that health aspects are extensively covered in the degree. In-depth and thorough knowledge of architectural lighting design and health is stated as a programme objective. But no course in the programme outline mentions health in the title. In year 2, in a course entitled "Daylight and Architecture", we found the only occurrence of the word "health" (in relation to climate) in any of the courses listed. There are certainly other health concerns to consider.

When assessing the learning objectives listed in the course outline for "Daylight and Design Process", there is no learning objective related to health, despite health being listed as part of the teaching programme. When talking to staff and students, health aspects seemed to play a very minute role in the programme, despite the title of the degree programme and the programme's affiliation with the School of Technology and Health and the Division of Ergonomics. This is mostly related to the lack of expertise of the current lighting staff in the area of health. Furthermore, access to medical and health-related library resources appears to be extremely limited for students, not just for the lighting programmes, but also for students in ergonomics and medical engineering. Better arrangements might perhaps be agreed with the Karolinska Institute.

If KTH elects to maintain the title architectural lighting design and health, the latter part of the degree programme requires urgent attention.

The architectural lighting design programme is currently a very small programme with few permanent staff members. Jan Ejhed has officially retried, but remains employed at 80 % at KTH and 20 % at Lineäus University, possibly until a replacement for the position of Programme Director is found. His wife, Agneta, plans to retire next year. She is currently the Programme Coordinator, but does not teach. Over the past few years, two recent graduates – Federico Favero (Italy) and Diana Joels (Brazil) – were the only other full-time teachers. Diana has left the programme after the last semester and Federico has started his PhD research in June this year and so it is unlikely that he will be involved in active teaching for the next 3 years. However, he will continue to plan and schedule courses during that time. Two new teachers – Rodrigo Muro (Mexico) and Natalie Bell (Scotland), also fairly recent graduates of the programme, have started teaching at KTH this semester, but had not yet received work permits or employment contracts at the time of our visit. In addition to being questionable with respect to employment regulations, it could leave the programme very vulnerable if work permits cannot be obtained.

We consider appropriate staffing levels and experience a crucial factor in maintaining and strengthening the lighting design programmes at KTH. While student numbers are currently kept low intentionally (despite large numbers of applicants), in order to maintain a close interaction between teachers and students, there is a clear need to employ further academic staff members. While approximately 10 external lecturers regularly return to KTH for specific input, the expertise of the current KTH-based teaching staff appears rather similar, and there is an obvious lack of on-site academics with a strong professional lighting practice background and up-to-date knowledge of advanced lighting technology, day lighting design and health-related effects of lighting. These are essential to fulfil the expectations set for the programme. Students have especially highlighted their desire for more regular interaction with lighting professionals based in the Stockholm area and for more balanced views on current lighting technology. Technology aspects currently appear to be predominantly covered by sales representatives of lighting manufacturers, potentially resulting in biased assessment of available options.

Teaching methods in all courses of the architectural lighting design programmes have been described by academic staff members and students as project-based learning in a design studio setting supported by occasional lectures (many provided by guests) and visits to lighting design projects relevant to the respective projects. Students work in groups of mixed ethnic and educational backgrounds and are apparently being assessed on the basis of joint design work (concepts, mock-ups, actual installations), as well as workbooks with personal reports and reflections on lecture contents, project work and results. From the samples we were able to view during our visit, the reflective component appeared rather weak. While several teachers seem to be involved in

the assessment, Jan Ejhed appears to be the only official examiner for every course in the two programmes. There is no evidence of an external review of the assessment process or an external assessment of the student work.

Students have expressed a concern about the limited range of teaching and learning methods as well as the evaluation process for which the rules are not clearly understood and apparently not disclosed at the start of a course. There appear to be three components influencing the final grade, and students have apparently been told that the final grade is based on the mark awarded for the weakest part of the assessment. Good performance in some other aspect is thus not recognised in the final assessment. This concerns us greatly. Feedback to students needs to be clearer and include helpful, honest and critical written comments on which students can reflect. These comments should clearly connect learning objectives and student performance in fulfilling these objectives.

While both Jan Ejhed and Federico Favero have completed the basic teaching courses offered by the KTH Learning Lab and have spoken positively about the experience, they have expressed a desire for additional support to further develop the teaching skills of all lighting programme staff. This seems appropriate given the limited teaching and assessment methods currently utilised in the lighting programmes.

Students and staff members also indicated a lack of support when it comes to resources. While, for example, computer laboratories exist at Haninge and lighting design students can access them, software that is relevant to their learning activities seems rather limited. Software to support graphical and spatial design activities should be readily accessible to students. Laboratory equipment for lighting design and analysis would also benefit from additions and upgrades.

There currently seems to be limited interaction with academic staff or students from other divisions in the School of Technology and Health (STH) or other schools and departments at KTH. An exception is the contribution of Per Nylén from Ergonomics, but he is only a part-time staff member at KTH. Obvious connections with KTH's School of Architecture and Built Environments appear to be absent, although some architecture students occasionally participate in one of the two lighting design courses offered at Haninge.

We have the strong impression that lighting academics are not sufficiently anchored in their school. The architectural lighting design programme staff members do not appear to participate in the ergonomics division staff meetings to which they formally belong. While potential synergies between ergonomics and lighting design clearly exist, this is – with the exception of Per Nylén's occasional lectures – not evident in the teaching programme or in research activities, perhaps because the other staff members in the ergonomics division are located at Flemingsberg campus.

RECOMMENDATIONS

Management staff members of the School of Technology and Health have verbally expressed their support for the architectural lighting design programmes during our visit. This needs to be followed up with a clear strategy to ensure effective management support structures and adequate resourcing of the programmes, particularly when it comes to employing and developing academic staff. The lighting programmes need to feel at home in the School of Technology and Health.

International advertising for a new programme director for the architectural lighting design degrees at professorial level should start immediately to ensure the survival of the programme, which appears to be severely threatened at present. The new director should preferably be well established in professional lighting design practice as well as in related research or development. Additional academic staff should be recruited from other universities and research institutions, as well as professional practice, and should represent different aspects of the programme content and approaches, especially in the area of lighting and health. We strongly advise against the current practice of sole recruitment from recent graduates of the KTH lighting design programmes, as this will likely limit the future development.

To strengthen the architectural lighting design programmes at KTH, we suggest a careful review of the programme goals, learning objectives and a subsequent alignment of the course offerings and teaching methods with the agreed goals. Requirements for successful progression through the programme should be clearly stated. This process should focus on measurable objectives and outcomes and be led by the new programme director, supported by current staff and students and external experts from academia and relevant industry. CDIO (conceive, design, implement, operate) principles can be of great help when reviewing and revising programme goals and learning objectives.

Teaching and assessment methods would benefit from a wider variety. Course offerings in research and development methods, including perhaps optional sessions on entrepreneurship, should be considered to support the thesis project and allow students to evaluate their aptitude for possible lighting research careers or starting their own lighting business. Students would also benefit from the involvement of an increased number of practising professionals affiliated with the programmes. These professional should be trained in teaching methods through the KTH Learning Lab and preferably be

employed for a period of several years to ensure effective utilisation of the investment.

Increasing staff numbers and revising teaching and learning methods would also allow KTH to reconsider the current student intake limitations, not just for economic reasons. It would perhaps be possible to run project-based lighting design courses in parallel with lecture and seminar-based courses, as well as short exercises or written assignments.

We also recommend improving the public and internal communication of the programme goals and objectives, as well as the specifics of the individual courses, including their teaching and assessment methods. As both lighting design programmes are offered in English, published materials and teaching must display a high standard of English language ability and must be easily accessible for potential students from abroad. Language support for students enrolled in the programme is also essential.

Design and research laboratories and related facilities should be developed further to include up-to-date lighting technology (lamps, luminaries, glazing, control systems etc.) and measurement equipment for assessing various aspects of the luminous environment and the human response to lighting, as well as appropriate computing resources.

Academic staff in the lighting programmes would benefit from regular interaction with colleagues in related disciplines. We therefore recommend including a clear strategy for better integration of the architectural lighting programme staff and students into the School of Technology and Health. This may include reconsidering the physical placement of the lighting programmes and their facilities relative to other groupings. If feasible and appropriate, KTH ergonomics staff might be moved to Haninge to increase interaction with the lighting programmes and the design, work environment, safety and health research programmes. Synergies with ergonomics and other divisions within the school and with related disciplines in other KTH schools (especially Architecture and Built Environments and perhaps Electrical Engineering) should be assessed to extend the health components of the 2-year master's programme in architectural lighting design and health, as well as the technology content in both programmes. This could include the joint teaching of students enrolled in various KTH programmes at different schools.

A stronger link between research and education is also essential. The Centre for Health and Building is an obvious candidate for such a link for both lighting and ergonomics, but others can certainly be identified at KTH and at the Karolinska Institute. The impact of lighting design and visual ergonomics on energy efficiency and sustainability of the built environment, as well as on occupant health and safety, are clearly areas for such cross-disciplinary teaching and research integration. The "All Ages Centre" is another obvious area for collaboration, as lighting design needs to respond to the specific needs of people in different age groups. Lighting is an essential component, especially for older people, which can help to maintain good health and independence.

FEEDBACK TO KTH MANAGEMENT

There seems to be a general need in the School of Technology and Health to enhance management structures and affiliations of programmes and staff members to the various units. Some programmes – although formally grouped together – seem to have little interaction. This appears to be partly caused by different campus locations and partly by significantly different professional approaches. We also encourage collaboration beyond the boundaries of STH to better utilise the available breath of research and teaching programmes at KTH. KTH senior management could act as a catalyst for such collaboration and support inter-school research and teaching programmes in areas identified as strategically important for KTH or in areas providing fundamental knowledge and input for large portions of the university. The mathematics section could be one such area, as it supplies services to many teaching and research programmes. We perceive a clear benefit from closer attention of mathematics to the needs of other university groups.

It seems that KTH senior management makes many decisions which do not flow through the organisation, i.e. they are not owned by the majority of staff or students. This might point to a lack of debate on important topics within the university prior to making critical decisions.
We suggest that senior management ensures wide and sufficient consultation with all sectors of the university affected by such decisions. This will help to unite staff (and students) in their efforts to strengthen KTH.

Some of the evaluations on student satisfaction seem a bit strange. One example is the evaluation in which the question to the student is whether he/she would choose the same programme again. From the answers it seems that the students would not do this, but when we interviewed both teachers and students they seemed to think it is not true because of what the students say and do after they graduate. This is something that KTH needs to consider. If evaluations are going to lead to improvement they need to be followed up and every part of the organisation (school management, program directors etc.) needs to understand the meaning and outcome of the evaluation. Otherwise it is difficult to make any improvement.

IDEAS

- Encourage alumni associations for all schools/programmes.
- Make CDIO and sustainability penetrate better in the organisation (e.g. offer workshops to introduce concepts).

Feedback regarding the EAE methodology

A well-organised project regarding information and help/instructions send out to evaluators, practical issues during the week in Stockholm and a helpful/positive attitude from project management.

But the interest and the presentations by the Faculty Dean and Deputy Dean at the start of our visit to KTH could have been more prepared and clearer with respect to the aims and objectives which KTH set itself for the visit. Likewise, the final comments made by KTH's President seemed not to indicate so much engagement with or interest in what had been presented by the various review groups.

FEEDBACK

- Need to clarify the educational and research organisational chart and various responsibilities.
- How was the student satisfaction survey performed?
- More time was needed for interviews.
- Interviews with industry representatives would have been useful.

Appendix 1. EAE Panel of Assessors

Iréne Agerkvist	*Diamyd Medical AB*
Erik Back	*Linköping University (student representative)*
Torsten Braun	*University of Bern*
Erik Bruun	*Technical University of Denmark*
Michel Cassir	*Chimie ParisTech*
Martine Cazier	*Ecole Centrale Paris*
Kristoffer Danielsson	*Lund University (student representative)*
Harry Dankowicz	*University of Illinois*
Monica Divitini	*Norweigan University of Science and Technology*
Susan Eisenbach	*Imperial College London*
Kalevi Ekman	*Aalto University*
Mikael Enelund	*Chalmers University of Technology*
Carl Johan Fogelholm	*Aalto University*
Helena Glantz	*Urban Design*
Lars Hammar	*Vattenfall AB*
Lars Harrie	*Lund University*
Jørgen Hauberg	*The Royal Danish Academy of Fine Arts*
Kas Hemmes	*Delft University of Technology*
Martyn Hill	*University of Southampton*
Rune Hjelsvold	*Gjøvik University College*
Jonna Holmgren	*Uppsala University (student representative)*
Jan-Olov Höög	*Karolinska Institutet*
Arieh Iserles	*University of Cambridge*
Kjell Jeppson	*Chalmers University of Technology*
Kerstin Johnsson	*Lund University (student representative)*
Kenneth Järrendahl	*Linköping University*
Björn Klöve	*University of Oulu*
Agnes Kåregård	*Uppsala University (student representative)*
Åsa Lindberg-Sand	*Lund University*
Erika Löfström	*University of Helsinki*
Lauri Malmi	*Aalto University*
Johan Malmqvist	*Chalmers University of Technology*
Fiona Martland	*Engineering Professors' Council*
Peter Munkebo Hussmann	*Technical University of Denmark*
Teresia Olsson	*Lund University (student representative)*
Werner Osterhaus	*Aarhus University*
Anna-Lisa Osvalder	*Chalmers University of Technology*
Kristian Ranestad	*University of Oslo*
Alejandro Rodriguez Gómez	*UPC-Barcelona Tech*
Norma Ryan	*University College Cork*
Ann Segerborg-Fick	*Scania*
Göran Sjöberg	*Volvo*
Olle Söderman	*Lund University*
Clara Tholin	*Chalmers University of Technology (student representative)*
Tim Torvatn	*Norweigan University of Science and Technology*
John Tucker	*Swansea University*
Esko Turunen	*Tampere University of Technology*
Jos Vander Sloten	*Katholieke Universiteit Leuven*
Martin Västermark	*Uppsala University (student representative)*
Michael Williams	*Ericsson*

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