

***Informatics Study Programme Group Evaluation in Estonia -
A Report about Assessments at
Tallinn University of Technology and University of Tartu***

Abstract

This report describes the results of an Informatics and Information Technology Study Programme Group Assessment carried out as a peer review at Tallinn University of Technology and University of Tartu. The main goal of the report is to give recommendations for further improvement in both institutions. So, no grades have been given. The recommendations are on different levels: (a) for the study programme group at Tallinn as well as for the group at Tartu. Furthermore (b) specific recommendations for the separate study programmes and (c) strategic comments for both universities have been collected. Finally, as the study group assessment was done as a pilot project, recommendations for improvement of that assessment procedure are given. This, however, is done in a separate document.

We found engaged people in the rectorates, staff of departments and faculties, but also students in both universities. So, both universities are on a track which promises even greater success. Nevertheless, the following report contains a lot of recommendations for further improvement, which can further and remarkably improve the state of recognition according to various aspects of both universities.

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1. Introductory Remarks

The *aim* of the assessment was the *evaluation* of a so-called *study group*, where 14 study programmes at *Tallinn University of Technology* (TUT) as well as 5 at *University of Tartu* (UT) each form one study programme group. Both study programme groups are in the fields of Informatics and Information Technology. A study programme group evaluates not only the study programmes of that group, one after the other, but also tries to look at mutual relations, similarities, differences, and the coherence of the study programmes of a group, and also their efficient implementation.

The *audit team* started on November 5 with an introduction to the assessment procedure by EKKA, the Estonian Quality assurance organization for education, which was the organizer of the assessment. In the afternoon of the same day, the audit team agreed on the organization of the visit, the different roles of the members, the results to be delivered by different members, and on a procedure to compile the results afterwards into a final report. The *evaluation* at TUT took place from November 6 to 7 and that at UT from November 8 to 9. Special procedures were taken for the Virumaa and the Kuressaare College, both of TUT, but outside of Tallinn. Two specialists of the audit team visited Virumaa College on Wednesday. Kuressaare College was “visited” by a video conference. On Saturday, November 10, the audit team agreed on the structure of the assessment report and the members delivered first sketches of some of its sections of the report. Afterwards the report was formulated, corrected, proofread, and sent to EKKA.

Audit team consisted of the following *persons*:

Prof. Liz Bacon, University of Greenwich, UK,

Prof. Laszlo Keviczky, Budapest University of Technology and Economics, Hungary,

Prof. Ernst W. Mayr, Technical University of Munich, Germany,

Prof. Manfred Nagl (Chairperson), RWTH Aachen University, Germany,

Prof. Ignas Niemegeers, Delft University of Technology, The Netherlands,

Virgo Inno, Tieto Estonian AS, Estonia,

Andres Kütt, Nortal, Estonia and other Baltic states, and student of MIT, USA,

Viljar Mee, Estonian Public Broadcasting, student of Tallinn University, Estonia,

Rain Rebane, Elion Ettevõtte AS, Estonia,

Hillar Bauman, coordinator of the assessment from EKKA, Estonia.

The *philosophy* of the audit team was in complete *coincidence* with the regulations of the *study programme group evaluation*: a critical analysis of the situation by recognized peers from outside, no grades but recommendations for improvement, the evaluated organization willing to discuss the recommendations in order to achieve further improvement. The audit team, however, would like to add, that a reasonable assessment can only be done on the grounds of study programme domain-specific information and knowledge.

Study programmes of *Informatics and Information Technology* are of great *importance for Estonia*. The state Estonia has decided to make these fields the drivers of its economy. Therefore, the quality of the study programmes in Estonia is of specific political and economical importance. This is especially important for TUT and UT, as both are the most traditional, important, and internationally visible universities for Informatics/ Information and Communication Technology in Estonia. We are going to characterize both universities shortly at the beginning of the corresponding assessment chapters.

The study group evaluation was also a new quality assurance procedure for EKKA. The assessment, described in this paper, was the first study programme group evaluation done in Estonia. That implies that some frictions occurred and a lot of possibilities for improvements exist for the future. Remarks in that direction, namely how a study group evaluation should be carried out and the existing one improved in the future are collected in a separate document.

2. Various Tasks for the Audit Team

The audit team had quite *different tasks*, which are briefly *classified and described* in the following section to see the breadth of the tasks, but also the possible future importance and impact of the delivered report.

Cooperation of Universities TUT and UT

Estonia is a small country with relatively few resources where establishment of critical mass is a common challenge. Therefore, it is very important for higher education providers to *cooperate by implementing shared study programmes* or sharing teaching staff. The audit team seeks to investigate the actual nature of cooperation between the universities TUT and UT and put forth recommendations about whether synergies achieved are or could be in line with the resources spent.

Study Programme Group evaluation

The main task of the audit team concerns the study programme groups (hereinafter referred to as SPGs). In order to make efficient use of the resources available while maximizing value generated the elements of the *SPGs must form a coherent whole* that caters for a wide spectrum of industry and student needs. That said, the various study programmes should be sufficiently distinct and allow for a clear differentiation of the academic degrees awarded. The study programme group evaluation comprises all findings which are not specific for a study programme but hold for all study programmes of one of the above universities

Study programme evaluations

In addition to the evaluation of SPGs, their *individual elements* were also assessed. While, given the limited amount of time allocated for the audit, it is difficult to provide detailed feedback on the content of specific courses, general and common *recommendations* can be given. These include but are not limited to a reflection on the spectrum of courses offered, the mechanisms that are in place to maintain the overall quality and integrity of the programme and the balance between different course elements.

Evaluation of the different Colleges of a University

Tallinn University of Technology (TUT) consists of 8 faculties, 4 research institutes, a scientific library, and 4 colleges (including the Virumaa College and the Kuressaare College, both outside of Tallinn). The Virumaa College was visited for one day by two members of the audit team on Wednesday. For the Kuressaare only a video conference could be organized. The task “evaluation of different colleges” should assess how the interaction of these different colleges works, how coherent the programmes

in different colleges are presented, how easy or difficult the transition is between the different study programmes of different colleges is, and alike.

Comments about IT in Estonia

None of the studies exists in a vacuum and all the study groups operate within a context of the Estonian ICT sector. There are *two main means of interaction*: demand for graduates and students as a workforce and supply of teaching resources and opportunities for practice. The audit team evaluates the nature and quality of these interactions. Also, we seek to identify if the relationships between the universities and industry are sustainable in nature and whether a long-term win-win situation can be observed.

Pilot Assessment and Improvements

In addition to reflecting on the subject of the SPG evaluation, the audit team is also aware of the pioneering essence of its endeavor. Therefore, difficulties in the assessment process are recorded and recommendations provided in order to make future similar audits more effective. These difficulties might stem from the resources supplied by the audit agency and the universities, from the clarity and scope of the tasks the team is expected to complete, or from the clarity and readability of the information provided to the audit team.

3. Assessment Report of TUT

3.1 A Short Characterization of TUT

TUT exists since 1918 and is the most important institution for research and education in technology domains in Estonia. Twenty English language study programmes for attracting foreign students are available. TUT is successful in attracting third party money for research, about 50% of its financial sources come from outside (it is an international trend that no university can survive only by the money from the state). TUT has about 14.500 students and 140 professors, in different research and education areas.

We had very open and interesting discussions and a corresponding exchange of ideas with the rector, vice rector, and persons responsible for the study programmes, the staff, the students, and the industry representatives (employees, employers, representatives of the Estonian Association of Information Technology and Communication, and alumni).

Since 1960 some form of ICT education and research has been found at TUT, but at that time was called cybernetics. Pioneering work was done at those times. All assessed study programmes are provided by the Faculty for Information Technology, in a cooperation of quite different departments and groups. A new building represents the drive of the ICT fields.

The importance of Informatics/ ICT at TUT is given by the following figures: The number of students in different fields is 2.600, there are about 20 professors and 200 employees. Interesting research work was presented to us, also by international and young professors.

Summing up: Informatics and ICT programmes of TUT and the TUT itself are on a good track with respect to quality improvement, international visibility, and the relationship of education to research.

However, further important steps can be made.

3.2 Study Programme Group Findings

This section contains general findings for the study group, which are not specific for a study programme and, therefore, are valid for all study programmes of the group. In the following sections, we report on our findings for each study programme that is a part of the assessment.

We found an openness in the discussions with the rector, vice rector, the people responsible for study programmes, staff, and the students. Especially remarkable was the discussion with representatives of ITL (Estonian Association of Information Technology and Communication, the ICT employers association in Estonia). Also, the discussions with employees of ICT companies around Tallinn was determined by a strong common interest in tightening the relations between universities in the ICT field and corresponding companies and to make use of these tight relations to gain an advantage for both sides.

This is also true for alumni, who stay in contact with their university and are also a part of this university. There is a network of companies, employees, and interested persons around TUT. This kind of tight cooperation we cannot find in other countries. However, the range of solutions should be extended from short-term also to medium- and long-term. For example, there is a tradeoff between immediate availability and productivity of graduates for development tasks right after graduation on one side, and the ability of employees in companies to acquire new information and knowledge by themselves throughout their life without using permanent corresponding lifelong education on the other side. In the latter case, the education has to be structured differently and on a long-term basis.

This network forms a good basis for tackling problems, like attracting more students to fill the gap due the lack of developers now in the ICT industry (the problem existing in most countries), raising the level of teaching at universities, feeding practical problems into academic study programmes, solving the drop-out rate problem, finding new ways for cooperation, developing the country in the direction of ICT products with a higher level of sophistication and quality, strengthening internationalization of education to follow the needs of the international ICT development market, solving the overwhelming demographic problem, and alike.

There are common projects of professors with industry with diverse advantages: more financial means on the university side, attracting further industrial members for giving lectures, academic persons knowing more about the industrial situation, industry knowing more about the difficulties and problems of the academic education. So, we recommend extending the number of these projects.

All study programmes of TUT have a strong basis in electrical engineering. This strong base is different from many universities in the international context but a reasonable way to offer Informatics programmes. It is not necessary that all programmes look the same. It is also good that students are forced to look outside their chosen field. ICT people need a broad view on the world, as they do later cooperate with people from different fields. Whether the course "Philosophy" in its current form is the right way to reach that goal should be questioned.

Strengthening the software part of the ICT education should be considered, as this is the main source for reaching the goals of the ICT and the e-strategy of Estonia.

Different fields of ICT practice in industry are covered by the study programmes Informatics, Business Information Technology, Electronics and Bionics, Communication Electronics, Computer and Systems Engineering, Telecommunication, Electronic Systems, Cyber Security, and Software Engineering (the latter two together with UT). However, the aims, the essence, the similarities, and the differences as well as the suitability for different fields in industry should be made explicit and communicated to students, employees, staff of universities etc. Especially, all these topics should be available on the website and – according to the ambition for being international – also completely in English.

Strengthening the movement to be a globally visible research university is only possible with international students and with local students being prepared for international exchanges. For that the number of English lectures has to be increased dramatically. The students are prepared for this change, as they have quite good English language skills. The usage of English textbooks should also be strengthened: the availability of (mostly English) books in the library has to be guaranteed, but there is also a need for a significant number of places open during a big part of the daytime, where students can study without being disturbed.

The cooperation with UT in organizing two study programmes (Cyber Security and Software Engineering) is quite good. Nevertheless, there seem to be several topics, which can be improved. The usage of remote and electronic teaching could help to solve the problem of the organization of the current study programme.

The drop-out problem seems to be severe. It is only shortly discussed in this section, as it is a global problem for Estonia and also holds for UT. Most students work 30 to 40 hours per week in companies. This is not a situation of part-time studying, it is better described where studying is an extension of work practice. Different study programmes of TUT seem to be affected by this to a different degree. Is there information available for the different programmes and has this information been analyzed and evaluated? What are the corresponding action plans? What makes studying more attractive and working in industry less attractive? It may also be that students are not challenged enough, or that some courses are not attractive enough for students to attend. It seems also that some exams can be passed without going deep into the contents of these courses.

There are some specific problems which should be mentioned: the role of “natural science” in different study programmes, the level of mathematics, the appearance of programming of different forms and using different programming languages, the question of research-orientation of study programmes (where are students encouraged and directed towards research?), when are the corresponding basics taught, e.g. for theoretical informatics? Teaching of teamwork skills, where, in which form, in different degrees of depths? The relations between professional programmes and academic study programmes were not touched at all. Freedom for students to develop in different and individual directions: elective courses to be freely chosen, seminars, discussing original literature, giving presentations, having chances to go abroad, as early as possible, not only in the master programmes.

We found very good students, but we did not find their role in the central part of the improvement loop. It seems that students’ activities could and should be used more extensively.

The quality of bachelor or master theses we looked at were very different. We found very good ones, but also a remarkable part of medium quality theses.

The lecturers seem to be overloaded, too little time is available for research and other academic activities. Their status seems not to be very attractive.

3.2 Study Programme Findings

Bachelor and Master Computer and Systems Engineering

A. General Findings

Strengths:

- The user market of companies is mainly satisfied with the theoretical knowledge of the graduates.
- The graduates can easily find good work placements.
- The formal connections with the ICT industry are good on different level.
- The ICT industry is happy to support good students, good programmes and good research.
- The programme curriculum is comparable with any similar university programmes in all over the world.
- The international common language English is very much accepted by teachers, students and the employers.

Areas of Improvement:

- The practical experiments with teamwork should be considerably improved.
- The ambition level of the programmes is to be improved.
- Students should be taught to keep deadlines better.

Recommendations:

- Evolve the programmes to cover new fast expanding domains. In particular, there should be co-operation with Telecommunication and other programmes on this.
- Find more incentives to increase students' participation in exchange programmes.
- Find more possibilities to involve students in the departmental research work. That could compensate for the relatively low load of formal teaching.

B. Strengths and Areas for Improvement of Study Programme by Assessment Areas

B.1 Study programme and study programme development

Strengths and areas for improvement relating to the study programme and study programme development:

- There is a good relationship with the IT industry.
- The programmes are well balanced, with the right amount of non-technical subjects.

Recommendations:

- Try to find complex projects for the department and include more students in these projects.

- Develop activities to help students socialise and make friends. That is likely to increase the students' motivation to complete their study programme.

B.2. Resources

Strengths and areas for improvement relating to learning environment and resources:

- Lab equipment seems to be adequate. There is a lot of partnership with industry. However, there are considerable differences by departments depending on their external projects. More incentives are necessary to increase external engagement in some departments.

Recommendations:

- There is a need for more group spaces for the students (in particular BSc), where they can meet their peers.
- Make a long term plan for laboratory infrastructure, based on a vision on the programme's future. In particular the funding should be addressed.

B.3. Teaching and learning

Strengths and areas for improvement relating to the process of teaching and learning

Recommendations:

- Develop an e-learning plan.

B.4. Teaching staff

Strengths and areas for improvement relating to the teaching staff:

- The qualifications of the teaching staff are adequate.

Recommendations:

- Since TUT has the ambition of being a research university, make plans to evolve towards a situation where every teacher is involved in research and in work with PhD students.
- International acceptance is important for all ICT areas, considering citations and recognition of research projects.
- The participation of the centre of excellence formations in the daily work of teaching should be increased.

B.5. Students

Strengths and areas for improvement related to students:

- The motivation of BSc students needs to be improved.
- The ambition level of the programme should be raised, to increase the motivation level.
- It is necessary to involve students in the departmental work as soon as possible.

Bachelor and Master Electronics and Bionics, Master Communicative Electronics

A. General Findings

Strengths:

- The goal to create a clear signal processing and circuit design profile.
- The use of English as the language for the MSc programmes.
- Strong relationship with industry.

Areas of Improvement:

- The number of students is low and there is a shortage of graduates.
- There is no good perception among potential students of the field or the profession. The present profile is not clearly defined, nor based on a vision of how the field and the industry develop.
- The ambition level of the programme could be higher, given the low study load in comparison with good international programmes.

Recommendations:

- Take additional measures to raise interest among potential students, and increase the number of female students. Involving industry people reaching out to high schools, and emphasising exciting application domains, e.g., medical applications could do this.
- Compare the level of depth of the programme with that of top universities in the field. Add more depth to selected subjects and introduce more software and system-oriented subjects. Make sure that for every subject practice sessions are available, and for the MSc ensure that there is a good research component in the thesis.

B. Strengths and Areas for Improvement of Study Programme by Assessment Areas

B.1 Study programme and study programme development

Strengths and areas for improvement relating to the study programme and study programme development:

- The programmes are well balanced, with the right amount of non-technical subjects.
- Industry is actively participating in reflecting on and evolving the programme.

Recommendations:

- Create a common BSc programme for ICT related Electrical Engineering, which allows BSc graduates to choose between two MSc programmes: one aimed at smart electronic systems and components (merger of Electronics, Bionics and Communicative Electronics) on the one hand and Telecommunications, having a more systems profile, on the other hand. A single MSc programme is not recommended given the different nature of the professions, e.g., a telecoms engineer vs. an engineer working in a bio-medical field.
- Strengthen the knowledge of selected application domains where the programme has a strong position, e.g., bio-medical. Involve outside partners to achieve this.

- Take a long-term view of evolving the programme. The present needs of industry are very important, however the industry is very dynamic and students should be equipped for a lifelong career. This requires a solid and broad foundation in the programmes.

B.2 Resources

Strengths and areas for improvement relating to learning environment and resources:

- Lab equipment seems to be adequate. There is a lot of partnership with industry (including the actual designing and manufacturing chips by Texas Instruments).
- Still a lot of the teaching material is in Estonian, it is desirable that this would evolve towards all English, in particular for the MSc programmes.

Recommendations:

- Make a long term plan for the teaching and lab infrastructure, in particular the funding.
- Drop the development of MSc teaching material in Estonian.

B.3. Teaching and learning

Strengths and areas for improvement relating to the process of teaching and learning

Recommendations:

- Develop an e-learning plan.

B.4. Teaching staff

Strengths and areas for improvement relating to the teaching staff:

- The qualifications of the teaching staff are adequate.

Recommendations:

Since TUT has the ambition of being a research university, make plans to evolve towards a situation where every teacher is involved in research, in particular with PhD students.

B.5. Students

Strengths and areas for improvement related to students:

- The feedback from students through the university's central feedback system is almost nonexistent. There is individual feedback to lecturers but this is not documented.

Recommendations:

- Make feedback anonymous and obligatory, and make it public. Publicize the reaction and intended measures.

Bachelor and Master Informatics, Bachelor and Master Business Information Technology

A. General Findings

- Overall the programmes were found to be in a good state and provide a good theoretical foundation and underpinning for the field of study.
- The dropout rate is high due to the ability of students to find work in industry at an early stage in their degree programme.
- Resources and the staff student ratio were found to be good.
- Links with industry were very strong.
- E-learning support was found to be inconsistent across the programme.

Areas of improvement:

- An overall e-learning strategy should be implemented.
- There is a need to work with students to improve the dropout rates.

B. Strengths and Areas for Improvement of Study Programme by Assessment Areas

B.1 Study programme and study programme development

Strengths and areas for improvement relating to learning environment and resources:

- In terms of the content of the programmes, they were generally felt to provide a good theoretical foundation coupled with relevant practical skills although as commented in the overall study programme group, the balance of theory and practical may need to be reviewed for some modules.
- It was noted that the team felt that the offer of discrete mathematics was a better option for these students.
- All parties (staff, the panel and students) were not convinced of the need for physics in the Business Information Technology programmes. However, it was recognised that this was current university policy and although it provides a firm theoretical foundation for students, overall it was felt that other subjects might have more relevance for these students.
- The technologies used on the programmes were considered relevant, appropriate and up-to-date.
- The strong input and engagement from industry was welcomed, however industry felt that their input wasn't always taken on board. It was noted that there is inevitably a lag time between programme changes and the production of graduates, in addition to the fact that the academic programmes have their own constraints in terms of the balance between theory and practice. Overall it was felt that the relationship was working well.
- In terms of assessment, the general comments in the study group apply however the use of peer evaluation of assessment to support learning was welcomed.

Recommendations:

- Review whether the maths component should be changes to include more discrete maths.

- Subject to university policy, review the inclusion of physics in these programmes.
- Review the balance of practical application and theory in the modules.
- Work with industry to ensure there is a better understanding of the changes made and the time lag required to produce graduates benefitting from those changes.

B.2. Resources

Strengths and areas for improvement relating to learning environment and resources:

- Overall the resources for the programmes were felt to be good and a good range of support materials are available, mostly on-line but one lecturer uses his own book. The library resources and technical equipment was felt in general to be very good.
- In common with the overall study programme evaluation, it was felt that the materials provided to students such as lecture notes and recorded lectures should all be made available on one virtual learning environment (VLE), i.e. Moodle and that the university should specify a minimum set of materials that should be made available for all modules.

Recommendations:

- Make the materials available in the institution VLE and specify a minimum set of materials that all staff are required to provide to students.

B.3. Teaching and learning

Strengths and areas for improvement relating to the process of teaching and learning:

- There is no clear e-learning strategy
- An issue raised by employers was one of helping to develop the students' theoretical and practical knowledge of some of the techniques used in industry such as that of pair programming.
- Moving between study programmes was felt to be relatively easy and students were supported in doing so if they wished to move. The general strategy being that they had to pick up modules that had been missed.

Recommendations:

- Develop an e-learning plan.
- Enhance the use of industrial techniques in teaching such as pair programming.

B.4. Teaching staff

Strengths and areas for improvement relating to the teaching staff:

- The qualifications of the teaching staff are adequate
- Teaching staff have a good relationship with their students and good industry and international contacts. Students always welcoming more input from industry and foreign lecturers and staff are encouraged to make use of existing contacts and forge new contacts to enhance this type of input into the programme. It would be hoped that the sabbatical system can be used to facilitate these contacts if it can be made to work properly.

- Although students would always like more teachers, the staff student ratio is good in comparison with international standards. The use of teaching assistants was welcomed by students.
- The other issues mentioned in the study programme group report, such as those relating to staff development and the grading of assignments are relevant to these programmes.

Recommendations:

- Ensure staff is fully supported in taking sabbaticals to enhance their research work and international contacts.

B.5. Students

Strengths and areas for improvement related to students:

- These programmes suffer from the same issues of a significant student dropout rate, related to the challenges of the theoretical courses, and the fact that most students have full-time jobs in industry, many with employers who will not offer part-time work to support them with their studies.
- Staff needs to do more to persuade the students of the relevance of the maths and physics although most agreed the latter isn't that useful for the Business Information Technology students, and that replacing it with another subject which has more relevance to the programme would be appropriate. However, whilst it remains part of the curriculum, staff should try to help students understand the benefits of a firm theoretical foundation for their studies and explain its benefits to their future career.
- In common with the study programme comments, the issues of the lack of student feedback, the effectiveness of the IT Academy bursaries etc. all apply to these programmes.

Recommendations:

- Work with students to help them understand the benefits of studying physics whilst it remains a core part of the programme.
- Review student feedback to ensure it is more effective.
- Review the effectiveness of the IT Academy Bursaries.

Bachelor and Master Telecommunication

A. General Findings

Strengths:

- Graduates are very much appreciated by their employers, and have no problems finding employment.
- There is a clear view of the profile of the graduates that matches the industries they will be employed by presently.
- There is a good relationship with the industry.

- The use of English as the language for the MSc programmes.

Areas of Improvement:

- The curriculum seems to be oriented towards classical (infrastructure) telecommunications, but insufficiently takes into account the rapid evolution and expansion of modern fields.
- The ambition level of the programme could be higher, given the low study load in comparison with good international programmes.

Recommendations:

- Evolve the programme to cover new fast expanding domains, e.g., the Internet-of-things and machine-to-machine communication. Cooperate with Computer and Systems Engineering on this.
- Create a common BSc programme for ICT-related Electrical Engineering, which allows BSc graduates to choose between two MSc programmes: one aimed at smart electronic systems and components (merger of Electronics, Bionics and Communicative Electronics) on the one hand and Telecommunications, having a more systems profile, on the other hand. A single MSc programme is not recommended given the different nature of the professions, e.g., a telecoms engineer vs. an engineer working in a bio-medical field.

B. Strengths and Areas for Improvement of Study Programme by Assessment Areas

B.1 Study programme and study programme development

Strengths and areas for improvement relating to the study programme and study programme development:

- There is a good relationship with the telecommunications and IT industry.
- The programmes are well balanced, with the right amount of non-technical subjects.

Recommendations:

- Although the focus should be on the layers up to networking (electrical engineering domain), the context needs to be well understood and strengthened in the curriculum. Therefore put more emphasis on the higher layers (closer to the services), and also on optical communication.
- Expand the curriculum to cover non-traditional telecommunications, such as used in distributed systems, sensor networks, ad-hoc networks etc. and IT techniques in the telecommunications infrastructure, e.g., the use of cloud computing technology in radio-access networks. Given the workload of students there seems to be space for this.
- Address the area of security (beyond cryptography), in particular wireless security and network security.

B.2. Resources

Strengths and areas for improvement relating to learning environment and resources:

- The resources are adequate but need to be reconsidered in the light of the recommended evolution of the programme.
- A rather new central server-terminal environment is used in network laboratory environment and the latest WiFi, IP voice and switching test equipment is used.
- Some practicum equipment is out of date (4G is missing)

Recommendations:

- There is a need for more group spaces for the students (in particular BSc), where they can meet their peers. The social embedding is likely to increase the student's motivation.
- Make a long term plan for laboratory infrastructure, based on a vision on the programme's future. In particular the funding should be addressed. Explore possibilities to share facilities with IT technology groups at the university.
- Cooperate with mobile operators for 3G, 4G mobile network related practical studies.

B.3. Teaching and learning

Strengths and areas for improvement related to the process of teaching and learning:

- There is no clear e-learning strategy
- Presently most MSc thesis topics (the estimate by students was 90%) in this programme are coming from industry, and are linked to a job the student has at a company. This is an imbalance, since the exposure to research is low.

Recommendations:

- Develop an e-learning plan.
- Gradually increase the number of MSc thesis that are linked to research conducted by the scientific staff, including PhD students.

B.4. Teaching staff

Strengths and areas for improvement relating to the teaching staff:

- The qualifications of the teaching staff are adequate

Recommendations:

- Since TUT has the ambition of being a research university, make plans to evolve towards a situation where every teacher is involved in research, in particular with PhD students.

B.5. Students

Strengths and areas for improvement related to students:

- The motivation of BSc students needs to be improved.
- The ambition level of the programme should be raised, to increase the motivation level.

Master Cyber Security (TUT and TU)

A. General Findings

The self assessment document of the curriculum adequately gives a good overview of the study programme. The curriculum is based on industry best practises and is balanced between different areas like network security, software development, information technology development, and cryptography disciplines. It does not have any particular strengths in the areas of cryptographical foundations (in the mathematical sense) or the development of cryptographical algorithms. It was worked out in cooperation with local IT development, especially banking and telecom industry representatives. The overall study programme is motivated by the Cyber Security Strategy of Estonia.

Strengths:

- There is a clear need in the Estonian labour market for IT experts with a good cyber security background.
- Graduates are very much appreciated by their employers, and they have no problems finding interesting and well paid jobs.
- There is a good relationship and cooperation with industry.
- The curriculum is well balanced, with wide choices of specialization.
- There is good international cooperation.

Areas of Improvement:

- Courses of the curriculum are divided between TU and TUT. This, for obvious reasons, sometimes creates logistics troubles for the students.
- Better utilization of resources and better cooperation is recommended.
- Structured and single source of information (internal web), supportive communication is favoured.

Recommendations:

- Continue to develop the contents of the programme to cover new fast expanding domains, e.g., the Information value and protection, risk management, and new algorithmic and technological trends.
- Motivate students and teachers to better cooperate between TUT and TU.
- More intensive cooperation on the international level and exchange of students is recommended.
- Address the area of security and risk management, in particular concerning industry sectors like banking, networking, or services in cloud environment.

B. Strengths and Areas for Improvement of Study Programme by Assessment Areas

Resources

Strengths and areas for improvement relating to learning environment and resources:

- The resources are adequate but need to be reconsidered in the light of a recommended evolution of the programme.
- Modernization with latest technology of lab equipment for the practica is necessary.

Teaching and learning

Strengths and areas for improvement relating to the process of teaching and learning:

- There does not appear to be a clear e-learning strategy.
- High dropout rate in first year demands recognition.

Recommendations:

- Develop better e-learning offerings and less physical logistics between Tartu and Tallinn.
- Work out special, lighter programmes for Law and Social studies.
- Gradually increase the number of MSc theses linked to research, for candidates who would like to go on to PhD studies.

Teaching staff

Strengths and areas for improvement relating to the teaching staff:

- The qualifications of the teaching staff are adequate.

Recommendations:

- Find Motivation and attract deeper cooperation between TUT and TU, and be aware of the more recent algorithmic and technological developments.

Students

Strengths and areas for improvement related to students:

- The motivation of MSc students needs to be improved.
- The ambition level of the programme should be raised, to increase the motivation level.
- The work load implied by the study programme could/should be higher.

3.3 Summary of Conclusions and Recommendations

The assessment procedure is according to our philosophy that quality assurance has to be a matter of the involved departments and faculties, grading is neither necessary nor productive, and that suggestions and recommendations of respected peers are the most valuable element of any assessment or evaluation and, consequently, improvement.

Strengths

All of us felt we had a very good and open discussion with the rector, the study programme leaders, the staff, students, employees, alumni, and representatives of organizations. The open-minded at-

mosphere allowed a very good communication and made us hopeful that this report will have some impact.

We found extremely active and intensive relations to industry and a cooperation of different stakeholders. Examples are: these are done in industry, industry employees give a remarkable percentage of the lectures, a strategic discussion about the improvement of mutual relations is in progress. We have never seen a relation industry – academia that is so intense.

The shape and size of lecture halls, seminar rooms, lab rooms, library/ e-library, services, e-learning seems to be sufficient for the current status of development. Improvements in the future in the direction of practice-orientation, internationalization, a research university profile etc. should also imply an improvement of these resources.

Weaknesses

The study programmes' curriculum description in the form of a module handbook, with a description of the contents of modules, the relations between modules, a schedule, the determination of common parts across different study programmes, determination of different parts, argumentation that the different profiles of study programmes cover the needed education profiles for industry, could all have been better presented to the audit team. Instead, we got links to many electronic documents containing redundancy and differences not clearly pointed out, and without a concise description of the context and the environment, in which the study programmes are running. Perhaps EKKA could ensure that this is better organized in the future.

The same applied to the staff description: we got a lot of superfluous details, whereas the necessary information was missing.

Our assessment analysis, the suggestions we made would have gone even deeper, our recommendations would have been even more fruitful and with more impact, if the audit team visit would have been based on material which is usually provided for a study programme assessment or an accreditation.

The departments/ faculty delivered a SWOT analysis for the different 14 study programmes of TUT. The openness and quality of these analyses was different.

There is a tremendous drop-out rate, a problem which dominated the discussion at TUT, but also later at UT. As usual and everywhere, students have problems at the beginning of study programmes (due to a new environment, a much higher level of education, the basics from other disciplines presented at the beginning of the study programme etc.). Students are used to work in industry beginning with the second year of the bachelor. This is, in principle, good for students and enterprises.

However, in Estonia most students work for 20 to 40 hours per week, many of them from 30 to 40. There is not enough time for their studies. Many students incrementally step away from studies to industrial work. The drop-out rate seems to be more than 60%. That has to be repaired quickly. It is not sustainable to have well-paid students which do not graduate and leave the education institution without having taken profit of the full knowledge conveyed there. Due to the close relation, the openness to solve problems of mutual interests, and the accepted responsibility by industrial leaders, there is a good chance that the situation can be radically changed. It is also a task for TUT to make the status of being a student more attractive.

Suggestions

Make the feed-back loop more viable, give more room for students' activities and corresponding associations and bodies.

Give room for study programmes for ambitious students. The study programmes are mostly pre-determined now. Try to connect the programmes to research as early as possible, and introduce more elements for independent and highly motivated students (seminars, working groups, free and additional activities).

The profile of the different study programmes has to be clearly worked out, represented in written material and also information in the web, and has to be offensively presented to students, especially to outside and foreign students.

There should be stimulation for more interaction and integration, internally between groups and departments of TUT for education and research within the faculty. The relations to other faculties should also be strengthened. ICT to a large extent lives of the problems arising in other disciplines.

In the same way the cooperation with UT should be closer. We will come back to this topic later, after having described the actual forms of cooperation.

4. Assessment Report of Virumaa and Kuressare College

4.1 Virumaa College

Applied Information Technology ProfHE

Study programme and study programme development

Strengths and areas for improvement relating to the study programme and study programme development:

The study programme Applied Information Technology at VC is first of all directed to the needs of regional employers. However, there are also graduates finding jobs in the big cities (Tallinn and Tartu). The programme currently offers two specializations, viz. Telematics and Software Programming. About half of the courses are being taught in Russian, the other half in Estonian. There are no courses being taught in English.

Most students come from the region, but there are also quite a few from other countries (like Bulgaria or Slovakia).

Graduates go to work in many positions related to electronics or automation in local industry. Some go to work as regular IT specialist or software developers. There are also a few who go on to pursue a MSc degree.

A number of steps have been taken to improve the preparation of the students for their studies as well as for the quality of the course work. The general consensus is that many incoming students have deficiencies in their mathematics background and that the corresponding level at high school is too low. As a remedial measure, a preparatory course is offered in math (it does not count for the overall ECTS number required for the programme), it appears to be quite successful and about 70% of the incoming students (in AIT) take it. Also, the contact to the schools has been improved, so that

high school students can find out much earlier what they have to expect when studying at college. It was mentioned, for instance, that such wrong expectations are an important reason for the high drop-out rate.

It is quite hard for students to go for an exchange study abroad, mostly because of financial reasons. The Erasmus programme does not cover enough of the costs.

Concerning the high drop-out rate (at basically all of the institutions we visited), there is a manifold of reasons apart from what was just mentioned above. One might also be that the admission standards need to be improved. Others are founded in the current structure of the work force in the IT industry and the ongoing rapid changes there.

Recommendations:

- Continue implementing measures to lower the drop-out rate.
- Consider teaching some material about additional topics like Computer Vision or Data Mining or Data Description Languages.
- In relevant courses, put more emphasis on design questions.

Resources

Strengths and areas for improvement relating to learning environment and resources:

The students as well as the teaching staff are quite satisfied with their learning environment as well as the amount and the quality of resources that are available to them.

Recommendations:

Make good use of the very good equipment you have available.

Teaching and learning

Strengths and areas for improvement relating to the process of teaching and learning:

By and large, the students (current as well as former) are quite satisfied with the curriculum that is being offered, its breadth and also its coverage of the relevant technology and methods (there was only one suggestion: some teaching on module description languages might be added). The instruction and assessment is flexible and also adapting to the needs of individual students. It was also mentioned that for some (and only some) courses the teaching efficiency might be improved if they would be taught in a block fashion (and not spread out over the whole semester, with only very few hours per week). However, a considerable amount of learning material is available via VC's e-learning environment (Moodle, and also other systems).

The student feedback rate (on the course level) leaves something to be desired. However, the teachers do respond in return to all significant remarks (whether positive or negative).

Recommendations:

- Keep on designing and implementing measures to maintain high student interest and participation in the classes.

- Keep on providing up-to-date learning material in the e-learning environment.
- Encourage more and better use of textbook and original literature.
- Increase student feedback.

Teaching staff

Strengths and areas for improvement relating to the teaching staff:

Even though VC is an institution of ProfHE, the involvement of the teaching staff in scientific research (local as well as international) is considerable. Most have an MSc degree, a few are working towards a PhD degree. More than half of them have spent a longer period of time abroad (mostly during their time of study), and about the same proportion have publications in a conference or a journal.

Teachers go to work in companies for short periods of time to keep up to date with new trends. They also go to Moscow or St. Petersburg (and not Tallinn) to take some refresher courses or attend seminars on relevant specializations.

There are also plans by the College to invest, in the coming years, more into the current personnel, to enlist more people from industry to take part in the teaching and, possibly, to get one or two courses to be taught by foreigners. There are no plans, however, to hire any additional staff.

The teaching staff puts a lot of effort into maintaining and further developing the material available through the e-learning environment. Since the budget available for teaching is rather limited, additional funds often have to be acquired through individual projects.

Further improvements could be possible by increasing the international contacts for the teaching staff, also helping them to increase their efficiency doing research and preparing experiments.

Recommendations:

- Provide sustained support for the teaching staff for continued education and improvement.
- Allow the teaching staff more time for the development of up-to-date teaching material (in particular on-line).
- Implement improved measures for internationalization.

Students

Strengths and areas for improvement related to students:

Beginning students tend to have considerable deficiencies in their math background. There have also been complaints by some employers about the language proficiency (in Estonian!) of some students.

1. Concerning these points, remedial action has already been taken. An additional preparatory math course has been implemented, and appropriate language courses are being offered.
2. Advising students during their course of studies and in the case of individual problems is well organized and taken on by the students. To avoid many such problems to begin with, the College also implemented some measures like increased availability of distance learning, special

tutoring, individual help for placement etc. As a consequence, attendance in class has gone up and only very few students work on a job in addition to studying.

3. Contacts with industry are good and are also aided by the fact that all theses are defended with industry representatives present. The teaching staff also has enough contacts to industry to help in student placement. The employers are generally quite satisfied with both the number of graduates from the programme as well as with their quality (in spite of the comment on language proficiency given above). For some of the regional employers, the VC programme is a very important source for hiring personnel at the required high level of skills.
4. Students graduating from the programme in general don't have problems finding jobs, be it in the region or elsewhere (some even abroad). Clearly, for an institution of ProfHE, application areas have a big weight and proportion in the areas that are being taught. But it was also pointed out by alumni that good teaching of fundamentals and more theoretical concepts must be present and is needed.

Recommendations:

- Sustain your successful efforts to prepare high school graduates for your programme.
- Take care of the language problem mentioned by several employers.

Aggregate analysis of the study programme

Study programme	Drop-out rate needs to be addressed
Resources	OK
Teaching and Learning	Increase student feedback, new material
Teaching Staff	Advance qualification, internationalization
Students	Keep courses interesting

4.2 Kuressare College

Electronic Systems ProfHE

Study programme and study programme development

The curriculum was started initially as a Bachelor study, but because of accreditation it was changed to Professional High School in Kuressaare under TUT. This change helps to focus on more practical education requested by local employers. Using of TUT professional teaching staff for specific subjects is required to keep a high professional level. Admission is mostly based on the local region. Travelling of teachers is sometimes a problem because of the time schedule. It was told during the visit that the dropout rate in Kuressaare Collage is smaller than the TUT average, but in fact there are no graduates from 2011. The programme has a relatively small number of students.

In the Kuressaare area about 500 people are employed in the field of electronic system production and assembly. Local industry is supporting studies with practical work places. The content of the curriculum gives basic knowledge about electronics, programming, and communication. Practical

knowledge is acquired by making a measurement equipment prototype based on a microcontroller. The design of analogue and digital circuits and programming skills will be applied. This gives a good experience about electronic equipment design, implementation, and production. College managers together with TUT are already aware about the risk of a too narrow specialization. The development of a new curriculum to merge electronics and yacht building was proposed.

Strengths:

Good local industry support and demand for electronics engineers,
Regional education development support by the local municipality,
Sharing of expertise and facilities with TUT,
The college is playing an important role for regional development.

Recommendations:

Because of the big risk of a narrow specialization, the curriculum should be extended to larger areas. The proposed merger with yacht building industry topics might be not enough. Extending the curriculum with telecommunication, computer engineering and/or software development disciplines should be considered. A new and broader curriculum with Informatics and/or Telecommunication should be considered.

Resources

A SKYPE meeting with Kuressaare Management staff was organized, which actually did not work, because of technical reasons. The use of video lectures will give more flexibility and can save a lot of transportation expenses. During the assessment it was not possible to see the real teaching environment, but a sample of practical exercise equipment, namely a microcontroller board was shown. In TUT there is good access to library information. Mostly, literature is accessed electronically. Lecture presentations are mainly available in electronic format. Based on information from teaching staff, we find that modern electronic components and computing or/ programming methods are used. Sometimes low-level programming in ASSEMBLER is used. This gives students real hands-on experience on how computers work and perform. The lack of up-to-date resources at the site was mentioned.

Strengths and areas for improvement relating to learning environment and resources:

Utilisation of TUT resources and learning environment,

Internet learning,

Very low rate of graduates during past years.

Recommendations:

Curriculum reference material should be updated.

Teaching and learning

Cooperation with TUT seems to be good, the management of the college is acting independently.

Big uncertainties are seen,

Learning via Internet gives a lot of flexibilities and utilisation of teaching resources.

Recommendations:

A wide area of disciplines should be considered, because borders between communication technology and electronics are disappearing. Deeper knowledge of programming and administration of IT systems should be considered. Find out ways to increase the motivation of students to successfully finish their studies

Teaching staff

The teaching staff is motivated, but sometimes travelling to Kuressaare is complicated and time consuming. More lectures from the industry representatives will be expected.

5. Assessment Report of UT

Again, the reader will find the study programme group findings in the first section and study programme specific findings in the second, for every study programme.

5.1 A Short Characterization of UT

UT was founded in 1632 by the Swedish king Gustaphus Adolphus. UT has now 18.000 students, about 50% of the Estonian Doctoral defences are done at UT. UT contributes to a Center of Excellence in Estonia together with TUT. There is more international staff than at other universities in Estonia. UT is proud of their high citation indices and their 60 partner universities throughout the world. We found a clear strategy to reach the goals, set in the corresponding plan for 2009-2015.

Interesting is that study programmes are spread over the Faculty of Science and Technology and the Faculty of Mathematics and Computer Science. The Institute of Physics is responsible for hardware education or hardware-related education due to historical reasons. About 1000 students are studying CS, SE, and CE. There was a tremendous development in the last 10 years.

Again, we found an open atmosphere in the discussions with the vice rector, the vice dean, persons responsible for the study programmes, the staff, employers, employees, alumni, and especially with students of the different study programmes.

A big portion of the money for the ICT research is based on research projects, where the money comes from sources outside of UT (National Science Foundation of Estonia, EU, Estonian Industry etc.). This additional money allows also to provide a good education programme. The rectorate argues that there is a "good" financial situation in relation to other areas, due to the importance for the nationwide strategy of ICT, e-government, etc. The university, however, does not give extra

money for ICT but does not take “success” money away. There is an international trend that departments have “to care for their own to get the money they need”.

UT ICT is more open for internationalization: There are 25% young professors from outside, guest professors, and international Ph.D. students, Master courses are partially or totally given in English.

There is a new CS building. Labs, library etc. seem to be sufficient for the moment. However, there is an evident shortage of personal rooms. Assuming the growth of the past will continue for a while and further strengthening of internationalization, a bigger building will be necessary in the near future.

As at TUT, we found a very close and fruitful cooperation with industry: students make internships or theses there, employees give lectures (companies like to be known by students), employees and alumni discuss with university members about improvement of the mutual relations, some of the alumni go for PhD.

The audit team asked for very good and for weak theses. So, the theses we looked at were in a wide range. Some of them were very good, some very weak. We had the impression that the threshold for acceptance of the weak theses could and should be lifted a bit.

5.2 Findings Study Programme Group Informatics and Information Technology

A. General findings

Strengths:

Overall the university provides a good learning environment for the students. They are well supported; the staff is very committed to teaching, supporting their students and clearly has a good working relationship with them.

Areas of Improvement:

The different study programmes of the SPG are in a heterogeneous state and hence in part hard to compare, in particular since some programmes have started only a few years ago and there are not enough data yet for conclusions based on reasonable statistics. Nonetheless, when rating the study programmes on an international level, the study workload required from students seems to be rather on the low side (by something like 30%) in some of the study programmes, maybe a bit less in the others. The level of requirements should definitely be increased so that the graduates become more competitive (in the long run, and also internationally).

Another is the breadth of knowledge and expertise of the graduates, in particular, since more and more jobs require not just programming skills or narrow technical expertise, but also competence in design, usability issues, environmental impact, etc.

B: Strengths and Areas for Improvement of Study Programmes by assessment areas

B.1 Study programme and study programme development

Strengths and areas for improvement:

Involvement with industry is strong, with employers regularly engaged in the delivery of modules and regular guest lectures. These lectures are very well received by the students who would both welcome more classes taught by industry, if possible.

There are courses on entrepreneurship, which given the number of start-ups in Estonia is valued and found to be useful by students. Also the support from the university in offering practical help and advice in launching the start-ups is impressive, and clearly works well.

The increase in soft skills development such as team work is welcomed by industry. However, students without work experience have not developed an appropriate work ethic regarding time management and deadlines. It is felt that one of the reasons for this is the relatively lax approach to deadlines taken by staff within the university and the ease with which students can get extensions on assignments from many lecturers. A strong recommendation would be to implement a consistent and fair policy regarding deadlines and extensions which will also help students to develop an appropriate work ethic. This will also help students to have a clear understanding of what is expected from them by all teaching staff and provide a consistent and fair educational environment.

Grades awarded for work submitted is at the heart of an institution's standards. The panel felt that some of the BSc and MSc theses they saw were on the low side for a pass in comparison with international standards and some students also commented that they felt others on the programme had passed with a quality of work that was too low, some staff yielding to pressure from students who were dissatisfied with their grade. Teaching staff should agree on some policy here to obtain consistent and fair grading.

Students made strong requests for more practical work. The theoretical material taught in the programmes is generally very good and this should not be lost. However, for some modules it is important to show more the relevance of the theory for the real-world. So, an appropriate balance between theory and practice needs to be found.

The panel understands that there is an Estonian Qualification Framework which is based on the European Qualification Framework and continued work to reach the level of the latter is welcome.

The good information on the website however would be improved by integrating staff information that is now scattered around.

The initiative and volume of activity around talking to school pupils about higher education was commended.

It was noted that some employers were seeking students with a better and more integrated understanding of the entire systems lifecycle and in particular usability skills which are important for any system design.

B.2 Resources

Strengths and areas for improvement relating to learning environment and resources:

In general, the resources are very good and the initiative to provide all first year students with a laptop at UT is commended.

Overall, students were very happy with the library and the technology available to support their programmes.

However, there are problems with (office and lab) space (at CS) and the lack of more modern equipment and tooling (at CE); these issues will be commented on elsewhere.

B.3 Teaching and learning

Strengths and areas for improvement relating to the process of teaching and learning:

It was interesting to hear that students have different references regarding teaching materials. A large percentage prefers printed paper, another big cluster prefers the electronic versions. Almost all students agreed that personal teaching is important for the lab intensive courses. They also like the very good educators who deliver interesting lectures.

There is a good approach to detect plagiarism and cheating in student oral exams or presentations on their work. The development of a national database to check for plagiarism is welcome.

B.4 Teaching staff

Strengths and areas for improvement relating to the teaching staff:

The staff/student ratio is quite good, giving a chance for an even better future appearance in direction of a visible research university.

Many academic staff have a good range of international contacts which are utilized but not to their full extent. The feedback from students is that they would welcome more engagement from foreign lecturers if possible.

There are mechanisms in place to support additional funding to provide competitive salaries to attract international professors.

A system for staff development exists, however the evidence suggests that it entirely or largely staff driven which may mean that if a member of staff does not wish to update their skills, there is little or no action by management to suggest they should redress this. Although staff do submit an annual report, it was noted that casual conversations around staff development are informal and it is therefore recommended that an annual appraisal system is introduced for all staff to discuss performance, student feedback, career progression and other support for staff required to help them develop and enhance their performance.

There is some good practice at UT regarding regular sessions to discuss teaching issues and the sharing of good teaching practice. However, it was noted that these were poorly attended by staff. Whilst overall the quality of the teaching was found to be good by students, it is clear that many students do not attend because they find some teachers boring. Evidence suggests that staff are more reluctant to discuss teaching practice than their research or subject interests. However, in terms of encouraging student attendance and reducing dropouts, teaching ability is a critical component and staff development in the area of teaching practice should become as important for staff development as subject expertise.

The policy of a sabbatical semester once every 5 years is very welcome; however support and funding for this was not always forthcoming. This would improve research, international contacts and links with industry and should therefore be strongly encouraged by management and supported with appropriate funding.

All students commented on the accessibility of staff outside class contact (noting that many go beyond the call of duty providing cell phone numbers for students to contact them) etc. and this is to be commended.

B.5 Students

Strengths and areas for improvement related to students:

There is an excellent relationship with the students and alumni, all being very supportive and complementary about the provision.

UT engages in Erasmus exchange programmes to varying degrees in different programmes. However, it was noted that not many Estonian students travel abroad for a variety of reasons such as their local jobs. Many employers in Tartu were clearly supportive of students going abroad and are prepared to hold their jobs open for them. Foreign students are attracted to the programmes taught in English, with some programmes being over-subscribed.

UT has a very good system for student feedback, and evidence from students shows that actions are taken by the university management to resolve their issues.

5.3 Study Programme Findings

Bachelor and Master Computer Science

Study programme and study programme development

Strengths and areas for improvement:

The BSc study programme has been formed only recently, combining two earlier programmes (Information Technology and Computer Science). At the same time, the number of admissions to the new programme is substantially and appropriately increased, compared to the combined number from the predecessor programmes. This is done even though the department could not rely on any firm commitment for increased funding. In the MSc programme, the SE part was increased considerably.

A number of measures have been taken to help to decrease the (far too) big dropout rate, like 10 additional teaching assistants, but also continually increased course requirements (in order to better prepare the students). Since these measures are quite recent, it is clearly too early to judge their effectiveness.

There is also a feeling shared by many that the competence of incoming students in math needs some definite improvements.

Resources

Strengths and areas for improvement relating to learning environment and resources:

From the site visit, it has become clear that there is a shortage of space for offices and labs. It is not clear whether the University can provide for extension (or replacement) in another building, nor how realistic these options are.

No other resource problems were noted (except that students complained about meal portions in the cafeteria being too small).

Teaching and learning

Strengths and areas for improvement relating to the process of teaching and learning:

In order to counter the large dropout rates, the department has taken several measures, like considerably increasing the number of TAs, or spreading challenging courses out over the whole course of the study programme.

Some lectures and courses are more interesting than others, and students remark that lecturers from industry often give more motivating courses, because of their more immediate experience with “real life” (in IT) problems. Also, the teaching of theory should be combined (in an appropriate way) with studying applications (and demonstrating the benefits of theory for these). Obviously, this approach has to be adapted to the varying experience of the students.

Students are basically satisfied with the assessment of their work and the feedback, even though there were some comments on it sometimes being rather late (like more than 2 weeks). Students also expressed their feeling that the learning methodologies employed in the different courses prepared them quite well for teamwork.

Teaching staff

Strengths and areas for improvement relating to the teaching staff:

UT is in the process of improving the qualifications of the teaching staff considerably. By the year 2017, all lecturers will be required to have a PhD. Already now, teaching positions are awarded on a competitive basis and for a time span of 5 years. UT strives to fill more positions with candidates from abroad, and there are usually 3-6 applicants per position. Also, there are good incentives in place to increase one’s salary through research projects; as a matter of fact, almost 2/3 of the funding comes from this latter source.

Over the last few years, the size of the teaching staff has increased considerably, and there is also the hope that more people successful in industry can be convinced to share their expertise with students at the university.

Students

Strengths and areas for improvement related to students:

It is obvious that there are many reasons for the high dropout rate, including wrong expectations or preparedness of the incoming students, but also possibly too little rigour in the requirements for course and/or homework. Clearly, such improved and continuous assessment of the students' progress will also increase a lot the teachers' work load, but it will, in the long run, make the students much more competitive and thus increase their career perspectives. It will also make the study programmes then more attractive and thus have a self-enforcing effect.

Aggregate analysis of the study programme (*more important strengths and areas for improvement based on the previous analysis of the study programme*)

Master Software Engineering

The papers delivered for the evaluation of this study programme (curriculum, papers in the evaluation platform, activity plan, etc.) were altogether of good quality: realistic estimations, realistic description of the state of the art, and possible improvements.

A. General Findings

This is one of the study programmes being organized by TUT and UT. It is one organized by UT, and also available for TUT students.

Strengths:

- More international students, compared to other study programmes (50%)
- Lectures in English (different, compared to other study programmes)
- Students are selected
- Very good connections to industry: The usual topics, but also a personal connection to two industry R&D centres (ELIKO and STACC)
- Staff with to a big part international experience and reputation in research.

Areas of Improvement:

- Drop-out rate, a general problem to be solved, should be easier in the case of this master programme (due to a very close relationship to the local and national industry).
- Further improvement of the rate of industry people being involved in giving lectures.

Recommendations (although the situation is better than in other study programmes, the ambition should also be higher)

- Make lectures more demanding. Students want this to be attracted. Look for a common strategy with industry to get a balance between study time and work time of students for industry. Convince the local industry to look more for the medium- and long-term goals, not only for the short-term ones.
- Strengthen the PhD situation. You then can attract young researchers from outside
- Internationalization of Estonian students should be improved. Some argue that – due to economical reasons – they cannot go abroad.

B. Strengths and Areas for Improvement of Study Programme by Assessment Areas

B.1 Study programme and study programme development

Strengths and areas for improvement relating to the study programme and study programme development:

- Software Engineering programme with defined specializations (at the moment there are two)
- Ambition to educate future people, able to get a leading position in industry

Recommendations:

- At the moment two specializations (business administration software, embedded systems software) are supported. There are other interesting specializations, as already seen by the department, e.g. mobile applications, cloud applications, robotics, highly distributed applications, parallel applications etc. (see reports).
- The study programme is too traditional. There should be more room for interesting lectures with tight connection to current research. Furthermore, there should be more room for the development of bright and independent students. The stated ambition is to educate people for leading positions in industry. Those people must have room for developing their own decisions!
- Study programme description, especially in English, should contain the contents of the lectures, the relations between the lectures, the competences gained, the profile of the study programme, the typical workplaces in industry the study programme is preparing for etc. That information should be easily accessible from the website.
- Employers argue that students should have more experience in interdisciplinary thinking and arguing, user interface characteristics, deadline constraints, strictness of work organization, etc. A software lab course, where different students develop nontrivial and innovative software of bigger size, could help. Also, it could be useful to organize master theses in projects with interfaces, to have even more theses in cooperation with industry etc.
- Papers say that a Bachelor in Engineering, Business or Economics is sufficient for getting onto a master programme. Only after the assessment, we learned that there are provisions to fill the gaps by bridging courses. Again, this should be made easily visible for students.
- An internship in industry is part of the study programme. Afterwards, we heard that this internship can in parts be made as lab course within the Practice module.

B.2. Resources

Strengths and areas for improvement relating to learning environment and resources

Recommendations:

- In the longer run, if the extension rate of students keeps going, the number of academic staff has to be improved as well.
- We doubt whether the statement made in the evaluation platform paper is right, namely that due to the principle “one laptop per student” one almost does not need labs. For specialized areas like cryptography, embedded systems, user interface handling, robotics, sensor networks, etc. one will need labs and different ones.

- Due to the growth of students and research, the plans to get more space in buildings should be quickly brought forward.

B.3. Teaching and learning

Strengths and areas for improvement relating to the process of teaching and learning

Recommendations:

- Some lectures are more liked by students than others. This, however, has no consequences. The feedback mechanism seems not to work properly. The activity of cooperative and active students should be better used (students like demanding lectures).
- Due to the remarks made above the description of the study programme should be dramatically improved. At the moment one only finds a list of names, not of great value to students, other staff members, or even colleagues from outside.
- The cooperation of TUT and UT is to be improved: how to organize common programmes, making use of new forms of eLearning, making use of mutual research etc.

B.4. Teaching staff

Strengths and areas for improvement relating to the teaching staff

- A higher rate of foreign professors and lecturers compared to other fields in Informatics at Tartu.

Recommendations:

- Try to get or make use of international electronic lectures available on the web.
- Try to get guest lecturers even more than today on a two weeks basis, on a summer term basis (where there is some chance), and - which we think is not very probable - on a semester or year basis. There are some programmes to support the latter financially.
- Make better use of industry people willing to teach lectures. However, also pay attention to the quality of those lectures and lecturers.

B.5. Students

Strengths and areas for improvement related to students:

Students are engaged and selected. It seems that the department could even better make use of the engagement of students. Take them more serious. Let them be a part of the feedback loop.

Bachelor and Master Computer Engineering

A. General Findings

Strengths:

- The market of companies is mainly satisfied with the theoretical knowledge of the graduates.
- The graduates can easily find a proper job.

- The formal connections with the ICT industry are good.
- Students are active in space research and robotics related areas.

Areas of Improvement:

- The content and structure of the study programme is a relatively narrow part of computer engineering, generally covered at European universities. This is a situation resulting mostly from catering to local needs.

Recommendations:

- Find more strong research areas to ensure the sustainability of the programme.
- Find more incentives to increase students' participation in exchange programmes.

B. Strengths and Areas for Improvement of Study Programme by Assessment Areas

B.1 Study programme and study programme development

Strengths and areas for improvement relating to the study programme and study programme development:

- There is a good relationship with the IT industry.
- Well motivated staff
- The programmes are well balanced, with the right amount of non-technical subjects. The cooperation with Computer Science is vital

Recommendations:

- Try to find complex projects for the department and include more students in these projects.
- The social embedding is likely to increase the student's motivation.

B.2. Resources

Strengths and areas for improvement relating to learning environment and resources:

- Lab equipments seem to be adequate only in the robotics area. There is a lot of partnership with industry.
- Room facilities are old and need to be renovated.

Recommendations:

- Try to find more resources to invite more staff members from outside.
- Make a long term plan for laboratory infrastructure, based on a vision on the programme's future. In particular the funding should be addressed.
- The programme and the groups which manage it seem to be quite isolated: It is advised to look for synergies with other IT areas, within UT and also in general.

B.3. Teaching and learning

Strengths and areas for improvement relating to the process of teaching and learning

Recommendations:

- Develop an e-learning plan.
- Closer cooperation with TUT to utilise modern lab facilities.

B.4. Teaching staff

Strengths and areas for improvement relating to the teaching staff:

- The qualifications of the teaching staff are adequate. However, the teaching staff consists of many other professional educators which, usually, are not teaching in computer engineering curricula or doing research or development in that field.
- There is an internal evaluation process every 3 years. Systematic feedback from students is taken into account.
- Only some parts of the staff participate in real high level research projects. The most important area is space research, the second is some parts of robotics. This one (or one and half) leg is not enough for creating a sustainable future.

Recommendations:

- The list of staff indicates that a very high percentage of the educators have a PhD degree. Unfortunately, it is not shown where the degree is obtained (computer related areas or other subjects of physics).

B.5. Students

Strengths and areas for improvement related to students:

- One main motivation of BSc students is that they can participate in space satellite projects.
- Alumni are very happy with the theoretical background they got. They consider their education comparable to good universities in the rest of the world.

Recommendations:

- Students would like more foreign lecturers.
- They expect more practical lessons related to understand the theory. They consider the BSc programme too theoretical.

5.4 Summary of Conclusions and Recommendations

The university offers good IT programmes, which have a clear future, provided some measures are taken, and it keeps looking forward to adapt the programmes to the needs of society and the state of science. We feel however that the ambition level can be higher, definitely in view of the university's goal to strengthen its position as a research university.

It is important to ensure the curricula have sufficient breadth. Industry and people's careers are dynamic; hence students should receive a solid basis for life-long adaptation to these changes.

Students can be challenged more. The time they spend on their studies is lower than what is usual at the very good universities that offer similar degrees.

Despite specific areas of improvement the overall facilities and the support given by the university are very good. Links with industry and alumni are strong. The student/teacher ratio is excellent and it is the intention of the university to bring the quality of the teaching staff to a higher scientific level.

The alarming drop-out rate should be addressed urgently. The facts and reasons are known, and the university and the industry should cooperate to solve this problem.

The Computer Engineering programme needs extra attention. It is operating in a wide domain. Its sustainability can only be maintained if a few strong application domains are chosen and if a strong research component is developed. Presently the only serious pillar, which is also well connected to industry and international research institutes, is space systems. More is needed.

6. Strategic Topics

In the following, we make some remarks on the strategic level, going top-down from Estonia, to strategic topics for both universities TUT and UT, and also to their cooperation.

Strategic Topics for Estonia

ICT is regarded to be the driving force of Estonia's economy. The money has to be effectively used for this purpose. Estonia claims to be an e-Country or ICT country. It might be the only state having a Ministry for ICT.

Estonian research is quite successful in funding of research projects, especially getting funding from the EU, e.g. for Centers of Excellence. Also, a good progress is shown by the number of doctoral students, the number of IT companies per population etc. Currently, important topics like Software Engineering (for all kind of software development processes), communication, and cyber security, to name a few, have to be covered as well. Estonia has a remarkable number of foreign (mostly younger) professors, ahead of other formerly eastern states.

Very positive is the close connections between companies and universities. Companies are not only interested in getting new employees, company members are even remarkably engaged in academic education. There are also a big number of spin-offs, a viable technology transfer, there are activities to cooperate between universities and companies, organizations representing ICT companies, the Estonian Association for Informatics, etc. This is more than usually found in other countries.

The IT Academy in addition supports study programmes by giving stipends. ICT industry and industry representatives are in close discussion with TUT and UT to find out what economy needs and what universities can provide. That is a very fruitful strategic discussion. The goals addressed, however, should also be medium-and long-term: An IT leadership of Estonia can only be got and preserved, if not only the currently urgent problems are addressed but also those dealing with the question, what will be in 5 or 10 years.

TUT and UT are the two leading universities of Estonia in the ICT field. So, careful assessment of the education quality of those two universities is of importance for the strategic overall ICT goal of Estonia, but also for the effectiveness and efficiency of the cooperation of both universities.

There is a demographic problem in Estonia, as in other countries. It is handled offensively, better than in other countries. However, the need for life-long learning to decrease the problem seems to be an important task, which is not yet addressed. Here, again, ICT in general, and eLearning in its various forms in particular can help and thus strengthen the future status of Estonia.

The direction to make TUT and UT worldwide recognized research universities should be strengthened. For that, attracting interesting people from outside (lecturers and students) on one side is necessary, but also giving experience to students and lecturers from Estonia in international contexts. That altogether has to be achieved without losing these Estonian persons, who are the ICT drivers of Estonia's future.

Estonia has strong relations to other countries around the Baltic Sea, especially to Finland. It also has relations to Western Europe and also Eastern Europe, e.g. to Russia. Strengthening the relations to the universities in all these countries seems to be a good strategy. It is also worth thinking to reactivate the relation to other former cities of the Hanseatic League, being located from The Netherlands or Norway in the West to Tallinn in the East and also in all states around the Baltic Sea.

The international cooperation can also help to achieve even more money from outside. Estonia is quite successful in using EU money for Estonia's further development. As already said, getting money from outside from different sources is a topic for universities all over the world, due to shortage of financial resources nearly everywhere.

More cooperation is necessary between departments and groups, to structure the study programs, to find and structure their common parts, to make the different parts of study programmes evident. It seems that historical reasons prevent a closer collaboration. This cooperation across groups and departments is necessary to cover all the fields ICT by offering study programmes which give the suitable education for the profiles occurring in ICT industry.

Also, a closer cooperation in research across different groups and departments is necessary. To take one example: heavy and wide-spread distribution is a topic for distributed systems of operation systems in Computer Science, for sensor networks of Electrical Engineering, for cloud computing of Software Engineering, for distributed data bases and data stores in the sense of mining and consistency management of Computer Science, and so on. We did not find many examples of cooperation of this kind in order to use the different experience of different domains, to share resources, work out domain-unspecific solutions etc. So, synergies between different fields of ICT where similar problems are tackled should be used. This also makes it possible to be partners of bigger projects,

also in an international setting. We found examples that different groups did not know of each other, although working on related problems.

A general and also urgent problem is the high drop-out rate in nearly all study programmes. That is an international phenomenon. However, it has a specific Estonian occurrence: That students are working in industry is positive for their experience, but also for the companies. The amount of time they spend for their jobs (in most cases 20 to 40 hours per week), however, is not in balance with the goal to get the graduation of their study programme in a reasonable time. In many cases they successively get out of the study programme and get more and more into the status of a permanent employee. What is good for company and good for students is only a short term optimization. A middle- or long-term optimization is necessary in order to get more and better educated people which, especially, are able to develop innovative products. In this context also, as mentioned above, a mutual transition between academic and industrial positions is necessary.

These medium and long-term goals demand for a special responsibility of enterprises. As the collaboration between academia and industry is tighter than in many other countries there is the hope that an agreement is possible. To give an argument for the strategy: Students argue that a broad experience (demanding for 30-40 hours practical experience from work in industry) is necessary to improve the chance for getting a job after graduation. This workload, however, will prevent to successfully finish a study programme in many cases.

One vehicle for even closer collaboration between academia and industry is to make academic positions attractive and also to make the transition between academia and industry and vice versa attractive as well. The payment for professors at university (basic payment plus incentives) must be attractive to educate the most brilliant students of the next generation. The best professors and lecturers are necessary to reach this goal. In addition, a further qualification of these people must be possible. At the moment it seems not to be attractive to get an academic position. That is again not a situation which can hold in a longer time perspective and in a country which seeks to get a forward position in ICT.

More high-level international research partners are necessary. To express the ambition to be one of the leading research universities, these partners are to be selected more carefully.

Also, more lectures of foreign professors and lecturers would support the momentum in direction of an international research university. This can be done by improving the 2 weeks stays, which are the usual form of visit today, but also using the chance to get professors in the summer term for 4 to 6 weeks. It will not be easy to get people for a semester or even for a year. An ideal opportunity is to use the vehicle of available video lectures and remote discussions. The corresponding infrastructure is necessary for the TUT and UT cooperation anyhow.

Some people complain about the insufficient interface between secondary school and university. That again should be a problem easier to solve in a small state with many personal connections and the will to get forward in the next future.

The problems mentioned here are important for TUT and UT. They are not repeated in full length in the following sections which deal with the situations at TUT and UT.

Strategic Topics for TUT

There are many positive aspects looking on the education situation at TUT. They were mentioned above and will not be repeated here. Instead, we concentrate on those topics where we can initialize further improvement.

There is a new ICT building. This is a positive sign to the outside world, e.g. for us when visiting interesting new and international groups of the faculty. It is also positive for visits of international groups and cooperation with those groups. Nevertheless, having the recent growth of the ICT departments of TUT in mind and also their specific role for the national ICT strategy, the situation is not far to think about further extension of space and also a concentration of ICT groups in one building or in buildings close to each other.

The cooperation between departments and groups in education and research has to be improved. This is necessary for structuring a coherent study group structure, but also to better find possibilities for synergy in research. It seems that the group and department structure is only understandable by knowing the history.

TUT, besides its main college at Tallinn, has two further colleges, namely Virumaa and Kuressare. They both are devoted to professional education. The relation and interface between professional education and academic education seems to be clear. It is, however not clear to us whether all possibilities for transitions between professional and academic education are used. We see, that also in professional education we find young people who are able to switch to academic education, or which after the bachelor should continue with an academic master, after having been specifically supported for this change. The other direction is also useful.

The relation between practice and academia in education and research in Estonia, especially around Tallinn, are quite close. That should help to structure the corresponding study programmes, serving for the input of practical knowledge, helping to get new employees now and in the future. If the goals are defined not only for a short-term but also for a medium- and long-term horizon, this will help to be prepared for innovative products, transfer of ideas in both directions, transfer of persons in one and in future also in both directions.

Our findings and our suggestions for TUT could have been even more substantial, if the material which was sent to us would have been clearer, concise but understandable, carefully edited, and easier accessible. We found much redundancy in the self reports, sometimes only syntax and few semantics, a lot of unclear abbreviations, no explanation of the context etc.

The TUT drop-out rate is high (more than 60%). There is a low number of graduates. The rate seems to be higher in some study programmes (Informatics higher than Business Information Technology?). More than 80% of the 2nd year students have a job where they spend often much more than 50% of their time in industry. There are two reasons: on the one hand students have problems to get acquainted with the study situation and completing the basics of Math, Physics and other disciplines. On the other hand, as students work too much, they move away from studies and finally do not graduate. Both problems have to be tackled offensively. Means could be to make the working situation more uncomfortable and giving support for the study situation. But there is more to be done.

Strategic Topics for UT

Again, there are many positive things to report, which has been partially done in the report above.

The remarks about missing or improvable relations between groups and departments from the last section could be repeated one to one. This also applies for the relation between practice and academia in education and research and, especially for long-term horizon one should have in mind. Again, we could have got more substantial findings and also suggestions, if the material presented to us would have been better suited for preparation. Furthermore, the reasons and the means to tackle the drop-out rate are the same as given in the last section. Finally, there is also a new building, which in the short- and medium-term perspective will need some extension. Therefore, in the rest of the section we address some problems which are more specific for UT.

The education which is hardware-related or which is near to hardware is done by the Institute of Physics. It was already remarked that there is no research in those areas. So, to be mentioned again, we would strongly recommend searching for some research areas connected to that field of education. Furthermore, in that research areas the connections and relations to TUT should be intensified. It is against the rule of a research university, if there are fields which are merely taught. Furthermore, in that area (but not only in that area) it seems that there are also no connections to the CS Institute. It is difficult to motivate students, especially the good ones, to be active in a context which is purely related to teach standard knowledge.

Also the departments ST, CS, and IP should work more closely together for education, but also for research. There are many problems nowadays which are addressed from the hardware, the software, the application, and even from the theoretical side. This would also give the chance to apply for bigger research grants.

Although UT is outside-oriented – more than any other university in Estonia – there should be more exchange with the outside world, in Estonia but especially abroad. The means to reach that goal have been described above.

UT is quite successful in education and research. Nevertheless the numbers of Master students, Ph.D. students, numbers of young lecturers and professors are still too small. That was remarked from employees and also from alumni. Industry has to decide for short-term or long-term interests. At the moment they seem to want both immediately. Due to the tight connections between academia and industry, the agreement of a suitable and sustainable strategy could and should be possible.

Strategic Topics for TUT and UT

Both universities are on a good way to share loads and detect synergies by organizing common study programmes. That is done without reducing the clarity of the profiles of TUT and UT.

However, the organization of the study programmes which are shared (Cyber Security, organized by TUT, and Software Engineering, organized by UT) is suboptimal. There is some need to improve the situation. Students e.g. complain that they are transported to Tallinn, wait the whole day because there is no reasonable space for working, and listen in the evening to a lecture while being tired. The cyber security students stay for one semester in Tallinn or even go to Vilnius.

Why not making more use of e-learning facilities, remote discussions, organizing students cooperation for students of both places by new ICT means. That would fit for the overall goal of Estonia to make the country a ICT- , e-government-/ e-administration- etc. country.

The relation between professional education and research-oriented education and to research is clear. Both address different types of education and students. However, it appears that the students get into the “wrong” institution. So, the transition between both has to be made clear and supported by specific means. This might also be of use for the UT students.

Further collaboration between TUT and UT in education but also in research should be extended without destroying the different profiles of both institutions. One case for this is that in one institution there are strengths, which cannot be found in the other. Or, both parts together are able to apply for bigger research activities which would not be possible for a single institution.

7. Expectation of a Reply Report

Overall the provision has been found to be healthy and in good shape. However, the report has delivered a considerable number of recommendations which we hope will be implemented by both institutions in order to enhance the provision at both universities.

We would recommend that both universities set up a formal mechanism such as a panel or committee, to review the recommendations and produce a set of actions as to how each recommendation will be addressed, the resources required to implement the action, who is responsible, and the time-scales for delivery. Especially, an action plan and action implementation plan for all the measures taken as response to our recommendations would make the audit team very happy.

This will be valuable on the one hand for the audit team, as the members of it get a response to what will be done with the recommendations. On the other hand this response is also of great value for the Estonian Quality Assurance organization EKKA, as it will help to improve the organization of the study programme group assessments.

Finally, the panel would like to thank the staff, students and employers from both universities for their time, their open and honest discussions and their input to the process which we recognize is a new and evolving process. We wish both universities well for the future.

For the above mentioned audit team (Liz Bacon, Laslo Keviczky, Ernst W. Mayr, Manfred Nagl, Ignas Niemegeers, Virgo Inno, Andres Kütt, Viljar Mee, Rain Rebane)

Manfred Nagl