Higher Education Quality Assessment Centre of Estonia

Joint Final Report

Tallinn Technical University

Programs Assessed

6464110 Informatics (Bachelor)
7464109 Informatics (Master)
8464109 Informatics (Doctorate)
6542307 Computer and Systems Engineering (Bachelor)
7542301 Computer and Systems Engineering (Master)
8542301 Computer and Systems Engineering (Doctorate)
6542312 Telecommunication (Bachelor)
7542312 Telecommunication (Master)
8542312 Telecommunication (Doctorate)
6542310 Electronics and Biomedical Engineering (Bachelor)
7542310 Electronics and Biomedical Engineering (Master)
8542310 Electronics and Biomedical Engineering (Doctorate)

Visit Dates

17-18 February 1999

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Part I

General Overview

The Higher Education Quality Assessment Centre of Estonia has invited three university experts from Denmark, Germany, and the United States to review and make accreditation recommendations for twelve computer-related programs at Tallinn Technical University (hereinafter called "University"). The programs fall into the study domain of "Information Technology" (hereinafter called "IT Domain").

The IT Domain contains four study fields. They are Electronics and Biomedical Engineering (LAE), Telecommunications (LAC), Computer and Systems Engineering (LAS), and Informatics (LAP). Each study field has a separate bachelor, master, and doctoral program. The general studies for the four study fields, which comprise roughly the first two years of bachelor study, are the same for all bachelor programs.

The study fields are jointly directed by the Faculty of Systems Engineering and the Faculty of Information Processing. The Faculty of Systems Engineering comprises the Institute of Control Engineering and Automation, the Institute of Electronics, the Electronics Competence Center, and the Center of Biomedical Engineering. The Faculty of Information Processing comprises the Institute of Communications and Radio Engineering, The Institute of Computer Engineering, and the Institute of Software Engineering.

The expert team visited the University Wednesday and Thursday, 17-18 February 1999. The expert team met with and personally interviewed several full-time members of both faculties and of the computing center. It also conducted interviews with groups of graduate and undergraduate students. It visited all computer and technical laboratories at the two sites where the students could work with computers or technical laboratory equipment. It visited the library of the University and the local collection of volumes and periodicals within the Institutes. The expert team also met with the Vice-Rector during its introductory meeting.

At the conclusion of the visit, the expert team conducted an informal exit interview with the members of the faculties and highlighted some of the strengths and weaknesses of the programs under review. The expert team was well received by the members of the Faculties and in its opinion, the outcome was a positive and constructive experience for the University, the Faculties, and the Institutes.

What follows are the findings of the expert team (Part II), its general recommendations (Part III), and its accreditation conclusions (Part IV). In Part II, the findings are relative to the program standards as established by the Ministry of Education, which are found in Appendix 4 from the *Manual on Quality Assurance in Higher Education in Estonia* dated 1995 (hereinafter called "Standards"). It is the hope of the expert team that the Institutes, their Faculties, the University, and the Accreditation Council view its findings, recommendations, and conclusions as a constructive mechanism to improve the quality of the programs.

Part II

Findings

The following are the findings of the expert team. The self-study report submitted by the Institutes, the observations made at the time of the visit, and the supplementary material received by the expert team during the visit form the basis of these findings. The findings reflect the expert team's general observations about the four study fields. It indicates specific fields or programs when such distinction is necessary to avoid confusion. Due to the compactness of time during the visit, the expert team could not look very deeply into the twelve different study fields.

The expert team was generally impressed by the high standard of the equipment at the University where it existed. Unfortunately, not all areas and laboratories possess modern technological equipment. Equally, the expert team appreciates the degree of involvement in externally financed projects. It expresses its gratitude to those individuals who prepared the self-analysis reports for their clear presentations.

1: Structure and Management of Educational Policy

The expert team has received information on the organization of the areas of electronics and informatics. It understands that the organization is the result of a historical development and does not necessarily reflect a strictly logical plan.

The responsibilities for each area seem clear. However, the expert team did not sense the formulation of a general development plan for the faculties concerning growth in number of students, the growth of faculty members, the renewal of laboratory equipment, and new research fields. In particular, there should be a plan when to hire new faculty members to ease the age structure of the faculties. This is a concern relative to the Standards [201.1,2].

The expert team acknowledges that the computing center has initiated a new chair and that it will expand its activities by a new study field, which is a diploma study in computer network technology and formal verification methods. The expert team is of the opinion that the ingredients of this program are important. However, it is somewhat surprised to see the launching of a new study program in software technology apparently without coordination with the study field of informatics. The expert team does not completely understand the background for this initiative. There may be very good reasons, but it cautions that cooperation would be better than competition. The expert team did observe cooperation between formal verification methods and hardware design.

The expert team acknowledges the partition of the faculties and the curriculum for the four fields of study. However, the curricula do not provide guidelines for phasing out course modules that do not turn out to be successful and criteria for introducing new courses in relevant areas. There is no systematic procedure in place for analyzing the academic quality of the program. The quality control mechanisms are carried out only as an ad hoc activity of the professors in charge of the program. This is a deficiency regarding the Standards [201.3].

There does not seem to be an explicit supervisory system to monitor performance of staff and this is a deficiency regarding the Standards [201.4]. Again, this is the responsibility of the professors in the department. The performance of students is monitored by their progress in completing their weekly exercises and by examinations in the examination period after the end of the term. The participation of the units in the study fields appears well defined. These activities satisfy the Standards [201.4 and 201.5].

2: Students

Admission quotas for the study programs do not correspond to labor market conditions, which is a deficiency regarding the Standards [202.1]. (See General Recommendations in Part III.) The University sets the admission quotas for each study field before it admits students to the bachelor programs. The planned admission quota in 1997 was 30 for LAC, 40 for LAE, 60 for LAP, and 80 for LAS with about 10% higher admissions in reality for LAC, LAP, and LAS. There have been widely varying admission rates concerning the different study fields. These quota resulted into the following: for LAP only 69 of 255 applicants (ratio 1 out of 4.25), for LAS 91 out of 215 (ratio 1 out

of 2.69), for LAC 34 out of 90 (1 out of 3). For LAE, the University admitted all applicants (with five places left open).

Students' educational level corresponds to admission requirements. The education entry level is adequate (gymnasium/secondary school); there are systematic approaches to help students with academic deficiencies, which satisfies the Standards [202.2]. Admission procedures and student counseling seem complete, adequate, and well-organized. Monitoring of students is by examinations, which are judged as generally fair by the students and satisfies the Standards [202.3]. However, the expert team did not see that the faculties used the results to improve teaching program, which is a deficiency regarding the Standards [202.4]. The study programs are of high quality and are comparable to foreign universities, so student mobility is possible and widely used. Credits of foreign universities are honored in the IT Domain and satisfy the Standards [202.5].

Student Interviews

The expert team met two student groups: First, a group of 8 bachelor, 4 master and 2 doctoral students mainly from the field of Computer and Systems Engineering (LAS, some also of LAE and LAC). It also met with a second group of 11 bachelor and master students mainly from the field of Informatics. The students were generally very content with their study programs, quality of teaching and examination procedure. Computer access does not cause problems. There seems to be enough computers available and the Internet is heavily used. All students have access to email and use it extensively.

However, the quality of laboratory equipment is partly excellent, partly bad, and partly terrible. There is definitely need for more modern equipment in some laboratories. In particular in the laboratory-based study fields, the students sensed the need for more special tools, sensors, test objects and specialized software.

A specific problem arises for the students because the teachers often use the newest books available as course book, which is generally appreciated to meet the state-of-the-art requirements of teaching quality. However, these books are often available to students only in the limited amount of only a single library copy or no copy at all!! Here the expert team strongly suggests that many more course book copies be made available for students. Due to the fast development of information technology there is a constant high demand for new course books.

Most students do practical work in industry because nearly everybody seems to work in addition to his/her study. However, they would like to get more insight in high tech industry (which may not exist in most of the fields in Estonia). Perhaps a plan for traveling abroad to see high tech companies could be organized.

A few students voiced concern about sometimes boring basic lectures, which could be presented "more colorfully" by their teachers. Some teachers do not teach the newest contents and some are not "well-organized" enough. Teaching quality could be improved by systematic assessments of courses but is rarely done by teachers. Despite the fact that it is suggested in at least one of the self-evaluation reports that written course assessments are performed on a regular basis, the students can rarely remember to have seen such an assessment form. It is definitely not done on a regular basis up to now. This should be improved and the students should know its impact on the faculty members. (The expert team was later told that written assessments will be done regularly starting with this semester.)

The students use opportunities to visit universities of other countries. In particular several study travels have been done by students sponsored by TEMPUS. Scholarships are made known to them by the International Student Office of the University. Perhaps additional student exchange advisors should be appointed in the faculties that have specific knowledge about field-specific scholarships and mutual exchange agreements with foreign faculties of information technology. That person could even be in charge of actively arranging such exchange agreements on behalf of the students. Students said they would appreciate if they could do more traveling. They would also like more foreign lecturers to be invited.

3: Educational Study Program (Curriculum)

The goals of the study fields were clearly formulated. The curricula of the study fields are comparable with programs of similar institutions in Europe, which satisfies the Standards [203.1,2]. However, the program is not flexible to changing environments in Estonia, because more graduates in Information technology are needed than can be produced by the present quota. Moreover, there should be as much freedom as possible for the students to choose study fields. The quota of the study fields should reflect the students choices. In this area, it represents a deficiency regarding the Standards [203.3]. To optimize receptiveness of the contents of the study programs to the needs of

society, the expert team recommends an external advisory board consisting of professionals from industry and academia, but without representation from the University. For example, twice a year the advisory board would make general recommendations as to the actual needs of the Estonian society.

In general, the curricula permit students to obtain sufficient specialization in their subjects, which satisfies the Standards [203.4]. However, there is a severe concern in biomedical engineering, where specialization is not sufficient. This specialty should be supported and allowed to gradually increase in number of allowed students in balance with the resources of the unit. It seems wise to promote biomedical engineering in view of the advanced and steadily advancing state of technical equipment in hospitals worldwide.

With respect to the Standards [203.5], the access to relevant text books is a serious concern. Although the study material is partly printed by the University, partly available via the Internet, and partly via the library, the number of text books and of journals in the library seems insufficient. Concerning access to journals in computer science, the expert team recommends that University library become an institutional member of the ACM and of the IEEE Computer Society and join their digital libraries. This would provide a relatively inexpensive way for staff and students to access all publications of these two societies electronically in a convenient manner.

The educational program appears sound and the graduating procedures appear fair and in conformance to the graduation requirements. These satisfy the Standards [203.6 and 7]. The contents of study corresponds well to academic goals. In order to offer the newest knowledge and skills, the expert team recommend an increase of lectures by foreign scientists invited by the University.

There appears to be a severe problem concerning the state of some laboratories and the equipment they have. In particular, concerning the extremely sorry state of the lab equipment in the biomedical engineering laboratory. Due to this deficiency the faculty members are not able to demonstrate in their laboratory the "newest knowledge and skills" concerning medical equipment. The expert team wants to point out that the lab equipment deficiency concerns biomedical engineers that are going to be responsible for high-tech equipment in the Estonian hospitals. This is a deficiency relative to the Standards [203.8]. There is also a concern about the lack of formal quality assurance systems relative to the Standards [203.9]. (See also S206 on Feedback and Quality Assurance.)

4: The Educational (Teaching) Process

Teaching methods are rather standard, but teaching is generally of high quality, which satisfy the Standards [204.1]. However, the strive for teaching state-of-the-art contents with new course materials generates a demand of more textbooks and that also means several copies of the same new textbook be made available to students by the library. Computers and software are extensively used in teaching and learning and satisfies the Standards [204.2].

Congruous programs at different academic levels allow the transfer of students between universities. However, there is some concern about the mobility of students among the four study fields within the IT Domain due to the fixed quotas; this is a concern relative to the Standards [204.3]. A detailed academic calendar and well-organized study program is applied. No complaint was made by the students that indicates that student assessment is not fair and that examination procedure is not flexible enough. Therefore, the Standards [204.4 and 5] are satisfied.

5: Organization of Studies and Resources

The organization of studies seems well organized to the rational use of the students' time. Student counseling appears to be efficient and information about courses is available without difficulty. The faculty monitors and improves the organization of study when necessary. The Standards [205.1 and 2] are satisfied in these regards. However, the expert team is not aware of a systematic use of student loads, student grades, and of failures to phase out a course, which is a concern regarding the Standards [S205.3]. The distribution of study loads is made by the responsible professor. The expert team is very concerned about the lack of a plan of staff renewal, in particular, regarding the high age structure of a high percentage of the present staff members. This is a serious concern relative to the Standards [205.4].

The expert team is also concerned about industrial involvement of faculty members who pursue external enterprises. This can easily lead to diminished involvement in their basic research and their involvement in developing better academic programs for their students. However, the expert team did find that the number of faculty members is sufficient to perform the proposed study fields and that faculty members in general renew their knowledge by traveling to foreign conferences, which satisfies the Standards [205.5]. Nevertheless, there is a problem about sufficient resources to fulfill the goals

of the study programs, which is a concern regarding the Standards [205.6]. This is particularly evident in some of the laboratories. The cooperation between the faculties and the administration exists and allows the faculties to make educational policy; this satisfies the Standards [205.7].

6: Feedback and Quality Assurance

The expert team believes that the University is aware about the working careers of graduates and knows about employers' opinions about the education, because of the strong links between the faculty member and industry in all fields of the IT Domain. However, the expert team did not find that data are gathered systematically. The University should strengthen its relations with its graduates through an active alumni association. This would permit systematic access to graduates' careers. Furthermore, it gives the opportunity to mediate concerns about engineering education to the politicians through such an association. An alumni association is also useful for better relations to industry for support. The expert team senses a weakness in that students and graduates do not in a formal way participate in quality assurance of the programs in the IT Domain. These are concerns relative to the Standards [206.1,2,3].

Part III

General Recommendations

The expert team offers the following recommendations to the Institute and the University. The parties should view these recommendations as suggestions from colleagues as and adjunct to but not part of its official findings mentioned in Part II. The expert team has not given these recommendations in any order of priority and the Institute and the University may consider them for the general improvement of its programs.

?? The Estonian credit point system (40 credits per full study year) differs from other credit point systems. For example, universities in USA use 30 semester-credits per year; European Union countries use the European Credit Transfer System (ECTS), which is 60 credits per year. Nevertheless, students can transfer credits by using the formula ECTS credits equal 1.5 times Estonian credits. However, it may be difficult to convince foreign universities on the transfer equivalence using the current system, especially since there are strong prospects for the incorporation of Estonia in the European Union.

?? The IT Domain should develop an external professional advisory board comprised of industry, business, and other computing professionals. This board can help ensure a system of analysis of the academic quality of its student programs. (See Standard 201.1) The Institute can also use this as a vehicle to conduct an outcome assessment of its programs.

?? The IT Domain should consider joining digital libraries, particularly those of the ACM and the IEEE Computer Society. Digital libraries have the power of desktop access to tens of thousands of professional articles at a fraction of the cost of paper copy publications.

?? The worldwide labor market indicates a high demand for computer professionals. The University seems to have ignored this demand, which is not met by the small number of students in the various fields of information technology in Estonia. However, it is difficult to estimate the labor market conditions in particular fields in Estonia. The Estonian electronics and software industry is bound to develop rapidly and the educational initiatives must closely match this development. The expert team realizes that an additional intake of students may be inhibited by too little space and by too few resources for laboratory equipment, but it most vigorously recommends the augmentation of the yearly quota of students.

?? There is a definite high demand for software (study field: Informatics) specialists, while the electronics, telecommunication and computer design (and embedded systems) labor market is probably not strongly developed yet. In the “telecommunications self-evaluation report” the labor market requirements are judged as met by the number of students of telecommunication (LAC).

?? The biomedical engineers that are educated as part of the LAE study field will be the specialists for medical equipment in hospitals or will work as consultants and representatives of foreign medical equipment companies (presently about 30 dependencies) in Estonia. Estimates by the head of Biomedical Engineering center are that at least 200 specialists are needed in hospitals by the year 2002 (although wages in hospitals may be too low to attract its graduates). There exist 160 hospitals and 40 polyclinics in Estonia with only about 30 engineers present. In accordance to the Statement Regulations in Estonia (State Acts on Radiation, Public Health, Consumer’s protection) a biomedical engineer or medical physicist should be present at radiological treatment and nuclear medicine procedures.

?? The expert team has no information on how many general electronic engineers are needed in Estonia. Graduates of Computer and Systems Engineering (LAS), which are specialists for chip design (ASICs and FPGAs) and for computers in technical appliances (so-called embedded systems), may meet an underdeveloped industry in Estonia. The graduates may be employed

either in the software market or they will go abroad because there is a worldwide lack of such specialists. The expert team suggests the establishment of organizational and financial aid by the Estonian government to allow such specialists to create small design centers to do contracting for foreign companies. Thus a new high technology industrial branch can be established in Estonia. A contribution of the university could be to offer office space and basic office expenses for a period of up to six months to help establish few-person upstart companies.

?? Concerning the quotas, altogether the expert team suggests a higher quota for the study area of "Information Technology" in particular for Informatics. It is not in a position to propose exact numbers from its short exposition to the overwhelming problems of Estonia. If it were to offer advice, it would be in the environment of a yearly increase of 20 percent in the next few years. This increase must be closely supported by resources for laboratory equipment. There are indications that up to a double load of students can be accommodated by the faculties with only reasonable additional support. Moreover, the quota restrictions between the different study fields may be relaxed allowing the students to choose a study field for the 3rd and 4th year of their bachelor studies with respect to their interests and where the jobs are. Students generally sense where job opportunities are best and dynamically choose these fields. This is much more favorable than setting quotas! However, we know that specific upper quotas may be useful, because of lack of lab space, teaching staff, and other resources necessary to hold the high quality of study. Electronics and in particular software is bound to be a decisive factor in industrial development in the next century. Estonia will miss an important opportunity if it does not strongly support education of its electronics and software engineers.

?? The expert team realizes that an important challenge for development of the Estonian society is a harmonious and fast development of electronic and software engineers together with the unavoidable surge of electronics and software industry. A balance must be found such that industry does not impoverish engineering education and research by attracting young talented researchers exclusively to industry. It is vital for development of Estonian society that industry is backed by a strong publicly financed research and education. This can only be accomplished by having a proportion of young scientists devote their talent to research and education.

?? An absolutely necessary component in a policy to reach this goal is to offer salaries to young scientists which are competitive with the salaries offered by industry. In return, the University must provide an exciting research environment to compete with Estonian industry for talents. Perhaps, and maybe most importantly, it must induce young scientists who have traveled abroad to increase their knowledge and to return to Estonia for their future career. The research possibilities for young professors should be made optimal by the universities in Estonia. This touches upon another delicate balance in Estonian science policy. Estonia must send its students abroad to bring back the newest knowledge. The danger is that the young may choose to stay away. It is our firm impression that students want to return to Estonia if at all financially possible. Hence, competitive salaries for young scientists combined with optimal research possibilities are the guarantee for a prosperous development.

Part IV

Accreditation Conclusions

The IT Domain has a dedicated faculty with a strong technical competence in information technology. The students of the IT Domain have an interest in the study of computing and possess an honest respect for their teachers. The members of the IT Domain reflect the tenets that form the basis of a technical university. The expert team was impressed by the dedication shown by the faculty and the students.

Notwithstanding the principles of faculty and students, there do exist deficiencies relative to the Standards established by the Estonian Ministry of Education. The expert team chose the term "deficiency" for a criterion of the Standards that is "not met" and *must be* removed within the time period (of two years) until the renewal of the accreditation. It chose the term "concern" for a criterion of the Standards that was a concern and that *should be* removed before the accreditation renewal. In the sequel we provide a listing of deficiencies and concerns that refers to the findings of Part II.

The deficiencies are abbreviated as follows.

1. No systematic procedure is in place for analyzing the academic quality of the program [201.3].
2. No explicit supervisory system to monitor performance of staff [201.4].
3. Admission quotas for the study programs do not correspond to labor market conditions [202.1].
4. The faculties do not use the results of monitoring student achievement to improve teaching program [202.4].
5. The quota of the study fields do not reflect students choices [203.3].
6. The extremely sorry state of the lab equipment in the biomedical engineering laboratory deserves immediate attention [203.8].

While not considered deficiencies regarding the program, the expert team has found areas of concern that should be address to improve the future development of the programs and to assist the next evaluation team. These areas include the following.

1. There should be a plan when to hire new faculty members to ease the age structure of the faculties [201.1,2].
2. There is a severe concern in biomedical engineering, where specialization is not sufficient [203.4].
3. Student access to textbooks [203.5].
4. A lack of formal quality assurance systems [203.9].
5. The mobility of students among the four study fields within the IT Domain due to the fixed quotas [204.3].
6. No systematic use of student loads, student grades, and of failures to phase out a course or improve the programs [205.3].
7. The lack of a plan of staff renewal, in particular, regarding the high age structure of a high percentage of the present staff members [205.4].
8. Sufficient resources to fulfill the goals of the study programs, particularly in some laboratories [205.6].
9. An effective ongoing systematic gathering of information for outcome assessment of the programs in the IT Domain [206.1,2,3].
10. Students sometimes like to change study fields after beginning of their studies and the imposed quotas limit such inter-field transfer.
11. Concerns about the age structure of faculty members may be alleviated by the recruitment of young faculty at higher salaries.
12. An effective long-rang plan should be considered to accommodate the evolving nature of computing.

13. The industrial involvement of faculty members may have a diminishing effect on the quality of the programs offered.
14. The computing center is exceeding its service role by offering a new diploma study program that diminishes the existing admission quotas of the IT Domain

Accreditation Recommendation for Bachelor, Master and Doctoral Programs in Informatics

Provisional Accreditation

The expert team has based its decision on the information received, the outcome of the accreditation visit, and the finding of deficiencies and concerns cited herein.

Accreditation Recommendation for Bachelor, Master and Doctoral Programs in Computer and Systems Engineering

Provisional Accreditation

The expert team has based its decision on the information received, the outcome of the accreditation visit, and the finding of deficiencies and concerns cited herein.

Accreditation Recommendation for Bachelor, Master and Doctoral Programs in Telecommunications

Provisional Accreditation

The expert team has based its decision on the information received, the outcome of the accreditation visit, and the finding of deficiencies and concerns cited herein.

Accreditation Recommendation for Bachelor, Master and Doctoral Programs in Electronics and Biomedical Engineering

Provisional Accreditation

The expert team has based its decision on the information received, the outcome of the accreditation visit, and the finding of deficiencies and concerns cited herein.