TUT Research Assessment Exercise 2011
Assessment Report

Panel IV: Faculty of Computing and Electrical Engineering

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Units of Assessment

Department of Communications Engineering
Department of Computer Systems
Department of Electrical Energy Engineering
Department of Electronics
Department of Signal Processing
Department of Software Systems
Pori Unit’s research in Electronics and Information Technology

The Panel was asked to assess research conducted at the Units of Assessment in comparison to research conducted in internationally recognized units all over the world in the field in question. The assessment period was 2005–2010. The Assessment Criteria were: Scientific Quality, Scientific Impact, Societal Impact, Research Environment, and Future Potential. The Assessment Scale was: Outstanding International Level (5), Very Good International Level (4), Good International Level (3), Fair International Level (2), and Poor International Level (1). In addition to assigning a numerical rating and preparing a written statement on each of the Assessment Criteria, the Panel was asked to provide an overview of the Unit as well as recommendations for the future.

The Panel was also invited to give more general comments on issues that it considered important. These can be found in the beginning of this Report.

The detailed guidelines for carrying out the Assessment were defined in the Terms of Reference Document, which is available on TUT’s website. The Site Visit Week took place in June 2011.
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GENERAL COMMENTS

The Faculty of Computing and Electrical Engineering is one of the five Faculties of the Tampere University of Technology and it consists of six departments. These six departments and (part of the) Pori Campus were evaluated. The Panel has done its upmost to be balanced and fair, while not shying away from reaching clear conclusions. All remarks are intended to be constructive and we hope that they will encourage research and education excellence. We not only provide feedback on specific departments, but also observations for the Faculty as a whole.

The main conclusion of the Panel is clear: the research in all of the departments and in the Pori Campus is generally good, often very good, and in some cases excellent. There are many motivated and dedicated researchers, working in dynamic departments. There are many impressive research groups that are competitive on an international level. The department heads are concerned with advancing their groups and the doctoral students are generally good, well-trained and well-motivated. The impact on local industry as reflected by the number of joint research projects and production of graduates is very good. The level of spin-off activity and technology transfer of research projects to industry is also a testament to the impact of the Faculty on local industry. The participation of female researchers appears good compared to other institutions.

Aside from these generally positive observations, the Panel has a number of concerns and recommendations in the following categories:

Publications

The field of Computing and Electrical Engineering has its own customs for quality publications which should be adopted. In particular, conference publications in computer science and computer engineering have the same (and often higher) value in comparison to journal publications. The value of conference publications in electrical engineering areas, however, is substantially lower. Further, in areas, such as electrical engineering, where journals are the highest impact publication venue, there are huge differences between journals. Thus it is crucial to identify and focus on the very best. This should be recognized in the evaluation of researchers, and research culture nurtured by the Faculty. In many groups, however, the current publication culture presents a problem and diminishes the quality and impact of the research endeavour. It is of utmost importance to focus on highest quality publication venues – journal and conference – even if this leads to fewer publications and even if the review process is prolonged. Faculty and student publication incentives that are in conflict with this strategy should be adjusted. The manner in which publications are currently counted (for raises and statistical reports) is suboptimal and can dilute the research quality. Specifically, abstract-reviewed papers should not be considered in the evaluation of research productivity. Publications, in journal and conference venues, should be divided into first tier and other.
Internationalization

The Faculty should aim for greater diversity among students and faculty. The number of professors trained in TUT or other Finnish institutions is too high. The Faculty should adopt a policy not to hire its own doctoral graduates unless they have held a postdoctoral position at a research institution outside of Finland for at least a year. Moreover, Master programs should be conducted in English. Except for the Department of Signal Processing, too few students and alumni conduct research abroad during their graduate studies and beyond. Similarly, the number of visitor exchanges in most departments should be increased. The way this was done in signal processing could be a model. The departments should consider establishing a colloquium series to attract strong international researchers to present seminars and engage the faculty. Outstanding TUT graduates who seem suitable for future TUT faculty positions should be encouraged to spend time abroad and, if they are at TUT, they should be allowed to build their own group and to be encouraged to publish independently from their former mentors.

Structure

The department structure of the Faculty of Computing and Electrical Engineering is complex and creates artificial boundaries. This approach led to the formation of departments that are often too small and do not match the mission suggested by their name. A number of the current departments were formed as spin-offs of the Department of Signal Processing and still emphasize signal processing research. Several of the current departmental titles do not reflect the actual research pursued. In these departments there are no professors who cover the core research area suggested by the department name. Consequently, these departments lack a clear identity. Departmental restructuring should be considered by combining departments and adding faculty positions to some departments in order to ensure that research is performed in their core areas. The Faculty would benefit from a more traditional structure, consisting of electronic devices, signal processing and communications, computer engineering, and computer science. This structure could be complemented by long-term strategic considerations of specific “niche” areas of focus that are of particular importance to TUT. Even a complete fusion of all departments in the Faculty is a possible option.

The Faculty should consider adopting the tenure-track system in all departments. The institution should employ an external academic advisor with tenure-track experience, possibly from the US, when implementing the tenure-track system and review process. The tenure track process should be conveyed very clearly time-wise and procedure-wise to new hires. Assistant professors should be assigned a mentor that can clarify the process and guide junior faculty to a successful academic career. At the same time, assistant professors should operate completely independently from senior professors, as in the American system. In hiring, the Faculty should strive foremost for highest quality and diversity in qualification and background. This includes avoiding the danger of “inbreeding” by hiring TUT graduates who never have been abroad. Outstanding TUT graduates who seem suitable for future TUT faculty positions should be allowed to build their own group and also on paper (e.g.,
publications) become independent.

There appears to be confusion in how to move to a new naming scheme for faculty members, in particular with lecturers that devote most of their time to teaching. Some international institutions have a teaching track, parallel to the tenure track with titles such as “Teaching assistant/associate professor.”

The hour-counting system currently used in the Faculty appears to be unsuitable for a university environment. The requirements to log working hours should be abolished. A more common practice is to have each member certify his or her effort in terms of percentage of time spent on a project once a semester.

The policy of paying out surplus funds over three years creates problems in terms of flexibility during periods of lower funding.

The currently used monetary reward system offered to doctoral students, whereby salary raises are provided for each published paper, should be discouraged and modified as the current system encourages fast publications in low-impact venues, rather than strong articles in first-class journals and conferences, as lower-quality publication venues offer a higher acceptance rate and faster publication cycle. This policy affects the publication quality of the Faculty and lowers the research impact and faculty visibility.

The statistical gathering system currently used should be improved, and accurate and timely data should be disseminated to the Faculty.

**Research**

There is a need for greater emphasis on creativity and industry-independent high-risk research that could lead to significant breakthroughs. The Faculty should thus be encouraged to transition from retroactive to proactive research.

Collaborative research, in particular cross-departmental or cross-faculty research projects, should be encouraged. Young academic faculty should be nurtured and provided guidance so that they are on a path to become independent researchers.

**External Funding**

The Faculty should be encouraged to apply for more EU funding, which is essential to increasing the visibility and competitiveness of the departments. This may require finding collaborators to participate in larger efforts. ERC applications, where possible, should be encouraged. Postdoctoral students should be encouraged to apply for Academy of Finland fellowships.

Companies’ eagerness to fund the Faculty for collaborative research is impressive. However,
in some cases the balance between publication of academic research and intellectual property rights are improper and favor the industry side. Contracts between university and industry for joint research projects should be fair and compensation should reflect the level of delay introduced in the publication of research results. The Faculty should consider adopting IP agreements that are more favorable to investigators and ensure that a reasonable amount of funds are provided to the investigator and the lab. Further, publication delays should be minimal and the right to publish the research results should be granted in a reasonable time; e.g., 6 months. The agreements and policies that top universities have with industry and technology transfer should be carefully inspected and should serve as a guideline to improving the current policy.

The innovations office of the University should provide better assistance to researchers during the patent application process.

The funding of some doctoral students depends only on short term industry projects. It is advisable to provide some form of support for these students in the case that project funding is not available anymore.
DEPARTMENT OF COMMUNICATIONS ENGINEERING

1. Overview

The Department of Communications Engineering conveyed a high-level of identity, unity, leadership, and organization. In addition, the diversity of the department is excellent in terms of its international flavor as faculty members come from different parts of the world (and not only from Finland), in terms of age as there is a good age balance, and in gender as there are two female researchers (one Docent and one postdoctoral). The area of communications is an important area in Electrical Engineering and should be strengthened and expanded.

Members of the Department of Communications Engineering currently conduct research in Signal Processing for Communications, Networks, and RF communication circuits, with the research in the Signal Processing for Communications (including DSP-based enhanced radio solutions and positioning) being the strongest.

The current department lacks members working in the core area of communications including modulation, channel coding, error correction, and other main communications topics. It is necessary to open at least one position (preferably two) and recruit a faculty member with expertise and solid research in the mainstream communications area in order to build up the department’s research in the main area of communications, which is currently not existent in this department. The current research conducted by members of this department is of good quality and this group has the potential to excel.

2. Scientific Quality of the Unit’s Research

Rating: Good International Level (3)

The conducted research has a good balance between theoretical and applied research. Members of the unit are working on timely areas. Their Academy of Finland’s funding has been on a steady rise for the last 4 years, as well as their Tekes funding. In addition, members of this department have secured recent AF funding in 2011 and are participating in collaborative sponsored research activities by collaborating with other departments within TUT (such as the Department of Electrical Energy Engineering) and international partners. Members of this department have also been leading COST activities with international partners. Their refereed publications have also been on the rise and some members of the group have publications in high impact journals with a reasonable number of citations. Some graduates have academic research positions.

The group should focus more on conducting high-quality basic research that can be published in high-impact journals; currently, some of the group members are avoiding first-class journals and publishing mainly in second-rate journals as these latter ones have a faster publication cycle. Furthermore, publications in mainstream communications journals
such as IEEE Transactions in Communications and IEEE Transactions on Information Theory are lacking.

3. **Scientific Impact of the Unit’s Research**

Rating: Good International Level (3)

Members in the department have joint refereed journal publications with international researchers. They have also initiated and organized international workshops and conferences. Members are serving on editorial boards of international journals.

There is no participation on editorial boards of high-impact IEEE/ACM communications journals. For academic positions, doctoral graduates are mainly recruited in the Department of Communications Engineering at TUT (5 recruited by the Department at TUT and 2 recruited by other universities). It would be good to get the doctoral alumni to work at other universities in order to increase the visibility of the department. As indicated previously, the department should focus more on publishing in higher-impact journals, which can significantly increase the scientific impact of the publications. Relatively, the research funding from the EU is low and seems to have decreased significantly from 2006 to 2010. Funding is mainly obtained from Tekes. The department should also focus on basic research in communications; a lot of the current work is focused on signal processing methods for communications. There are a lot of fundamental research problems in the telecom fields that do not involve signal processing. Since this is the Communications Engineering Department, visibility and impact can be increased by placing more focus on fundamental research problems in the telecom field.

4. **Societal Impact of the Unit’s Research**

Rating: Very Good International Level (4)

There are several collaborative projects with industry, with a very good level of funding from industry and Tekes. MSc theses projects are based on industry projects and are jointly co-supervised by industry partners. Entrepreneurship is present with spin-off companies founded by employees of the department and filed patents. There is also active participation in standardization activities in collaboration with industry partners.

5. **Research Environment at the Unit**

Rating: Good International Level (3)

The department has a solid identity in the sense that the members share the same vision and seem to work well together. Also, the department seems to have very good leadership. The environment has a strong diversity in terms of gender, origin, and age. The lab facilities
and space are very good. The department has also had several international exchanges and visitors.

Some of the taught courses cover subjects that heavily overlap with other departments, especially with the Department of Electronics but with a focus in telecom. On the research and development side, the circuits’ integration capabilities of these two departments are complementary and both groups could benefit from stronger ties and collaborations.

The number of courses to be taught is relatively high and some of these courses can perhaps be co-taught with other departments due to the overlap in the concepts that are covered in these courses (such as courses involving electronics). The department is not adequately resourced for the teaching that is required.

6. Future Potential of the Unit

Rating: Good International Level (3)

The members are very motivated and full of potential for future excellence. They understand the issues and they have solid plans that will help them improve the impact of their research work, including plans to increase inter-departmental and international collaborations, some of which are already underway and which already resulted in new funding from the Academy of Finland and other sources. In addition, they have solid plans to increase high-impact basic research and associated funding levels, as well as to strengthen interactions with alumni, and to increase the international visibility and recruitment capability of the department through active student recruiting from high-caliber universities (already started), joint doctoral programs, international exchange programs of TUT doctoral students, and the FiDiPro program.

The department needs also to have plans in targeting high-impact journals, in terms of publishing, serving on editorial boards, and in terms of initiating special issues in relation to research topics conducted by the department. Also, it is important to recruit core communications researchers that can conduct fundamental research in the communications area.

7. Recommendations for the Future

The university should establish at least one tenure track position for a core communications faculty member.

Members of the department should target refereed high-impact journals such as the IEEE Transactions including but not limited to the IEEE Transactions on Communications and the IEEE Transactions on Information Theory.
The department should keep working on increasing the level of funding from sources that do not depend heavily on industry, which would allow them to perform high-quality long-term basic research.

For additional details, please refer to the detailed recommendations in the previous sections.
DEPARTMENT OF COMPUTER SYSTEMS

1. Overview

The Department of Computer Systems is one of the smaller units in the Faculty of Computing and Electrical Engineering, with research led by five Professors. The Department grew out of the larger signal processing activity in the University, with a focus on implementation and application. Some of the research activity and output continues to be in the area of signal processing, with other notable work in embedded computing platforms. There is also work into new areas such as software radio and wireless sensor networks. Other areas in computer systems are not well represented, and the unit's work might be better described as embedded systems research with focus in signal processing. Overall, the research is applied in nature, and responsive to industry interests.

2. Scientific Quality of the Unit's Research

Rating: Good International Level (3)

The research in the unit is underpinned by a strong engineering ethos of developing systems, and less driven by research questions in the traditional sense. The research is consistently published through peer review on international level. Some of the work, notably more in signal processing than in computer systems, is published in journals of higher standing. However, overall there is a tendency to publish in less esteemed venues. The longer established research in signal processing and systems on chip is of solid quality while work on more recently developed topics such as wireless sensor networks is at this stage still trailing the state of the art.

In line with the unit's emphasis on engineering, the achievements highlighted for the reporting period include contributions to know-how, prototypes, tools, and patents. While the emphasis on building and demonstration of prototypes is commendable in systems research, it needs to be better framed by attention to fundamental research questions. In demonstration of their work, researchers trained in the Department showed strong technical competence but limited awareness of the wider research context.

3. Scientific Impact of the Unit’s Research

Rating: Fair International Level (2)

The unit's research appears strongly driven by engagement with industry. Results are published but too often in venues of lower impact. An area of good international visibility is systems-on-chip, for example with active engagement in conference organization. The longer-established research leaders in the Department are well-known in their particular fields but the level of international networking is not extensive, and there is no indication of
leadership, such as in development of new research initiatives in the wider community. Some of the professors are strongly engaged in knowledge transfer and spin-off activity, with less attention to developing their visibility in the scientific community.

The publication culture in the Department is not strongly convincing, as it often prioritizes fast turnaround over top quality. Research students in the Department are enthusiastic and demonstrate strong technical competence but may be less well trained in terms of awareness of the requirements for top level research.

4. Societal Impact of the Unit’s Research

Rating: Very Good International Level (4)

The Department has strong ties to industry, and the research is well informed by industrial needs. A wide range of collaborations are in place, with clear evidence of successful knowledge exchange. There is also notable innovation and spin-off activity, in particular led by dynamic younger research leaders in the unit.

Research training is predominantly in the context of industrial collaboration, resulting in a good supply of highly skilled professionals to Finnish industry.

5. Research Environment at the Unit

Rating: Fair International Level (2)

The research environment is good in terms of facilities. The funding has traditionally been dominated by support from Tekes and industry, and has fluctuated in recent years. The Department is aware that it needs to strengthen research income from the Academy, and from Europe and did so recently which is commendable.

A major concern is recruitment and staffing. All Professors now in post have been trained at Tampere and risen through the ranks. This has reinforced existing strength but has been detrimental to continual development. None of the academic staff have spend significant time abroad, and there has been no import of fresh ideas that would challenge the established research, and the unit’s research practices.

As a department the unit is too small and too narrow in scope.
6. Future Potential of the Unit

Rating: Fair International Level (2)

The Department is solidly positioned. In all areas of its activity, there is good awareness of trends in the field. The research leaders have clear ideas of how to maintain their position but there is no vision and planning of how the Department at large should develop.

The Department has good quality research, but is not well positioned as a Computer Systems unit. The scope of research has remained close to the Department’s roots in signal processing and digital hardware while core areas of Computer Systems are not represented.

7. Recommendations for the Future

The research activity has a strong engineering foundation and excellent industrial collaboration on which to build, but steps need to be taken to strengthen the research orientation and identity, and to increase the international outlook. The Department might benefit from restructuring as it lacks in diversity and critical mass, and does not have strong coverage of computer systems. A critical issue is staff mobility and internationalization.
DEPARTMENT OF ELECTRICAL ENERGY ENGINEERING

1. Overview

This Unit is focused on electric power distribution and power electronics. The main fields of interest are distribution networks, smart grids, energy efficiency in power usage, sustainable power production, and nanotechnology in electrical insulation materials.

The department includes 6 professors, 2 associate professors and other staff for a total of about 50 people. The size of the Unit is relatively small, which yields a remarkable sense of identity, which has been demonstrated during their presentations to the panel, in which they clearly illustrated who they are and what they do. The level of the applied research is considerably high, whereas the effort on the basic research is limited, due to the small size of the department and the lack of specific funds. Nevertheless the performance of this department is more than satisfactory in relation to the strategy of TUT:

- the number of publications in 2005-2010 is good despite the fact that a drop in the last two years has occurred;
- there are scientific collaborations with respected industries, universities and research centres in Finland and abroad;
- the societal impact is high: a significant part of the export of Finland is related to electrical energy.

2. Scientific Quality of the Unit’s Research

Rating: Good International Level (3)

The research activity in Electrical Energy Engineering is focused on applied research more than on basic research, probably due to lack of funding and the small size of the unit. Quality work is published in respected international journals and presented at international conferences. The number of publications per staff is satisfactory. Technological results are demonstrated by several prototypes and patents. The research activities are carried out in cooperation with highly recognized academic and industrial partners in Finland and abroad.

3. Scientific Impact of the Unit's Research

Rating: Good International Level (3)

The scientific impact is significant especially in emerging focus areas of research. It is testified by citations, awards, and invited papers. The role of the unit in applied research is recognized and supported by supplementary funding coming from industry and cooperative projects.
4. Societal Impact of the Unit’s Research

Rating: Very Good International Level (4)

Part of the research is carried out in close collaboration with companies, with an impact on patents, external funding and opportunities for doctoral students, post-docs, and professors (two positions supported for five years). Also noticeable is the presence of staff with significant experience in the industrial environment.

5. Research Environment at the Unit

Rating: Very Good International Level (4)

For most areas of research, the facilities are excellent. Doctoral students are satisfied with their situation: they can attend conferences and show interest in spending periods in foreign research centers. The research environment attracts high quality professors and research staff from abroad.

The size of the Department is very small and hence basic research has to be limited in order to concentrate the efforts on the applied research that is the channel for external funding. Only a small part of the external funds comes from the EU. Although the facilities are very good, the maintenance of the laboratories is problematic in the absence of specific funding for replacement of basic equipment.

6. Future Potential of the Unit

Rating: Very Good International Level (4)

The presence of foreign doctoral students, and the recruitment of top rank permanent and temporary staff demonstrates the attitude of the department to improve its capabilities. However, it should be noted that most of the post-docs have been recruited from inside.

The publication culture should be improved; not all the research staff publish their scientific results in top rank journals. Participation in scientific conferences without peer reviewed proceedings should not be discouraged, however the dissemination of significant results presented in a preliminary form to these symposia should then be re-organized and published in journals.

There are good plans for future research, giving priority to power electronics, and enlarging the group with the recruitment of a professor from abroad. The department will also play the leading role in a SHOK research project on smart grids for the next 5 years. Also investments on nanotechnology should be made.
Resources for basic research should be gathered, for instance, by applying for projects funded by the Academy of Finland.

7. Recommendations for the Future

The panel believes that the impact of the activities of this department is underestimated by the University. With focus in a field that gives rise to a significant part of the export of Finland, the amount of personnel is very small, considering the importance for the country and the good quality of the work and the future potential. There are areas of research like high voltage and nanotechnology that deserve to be reinforced.

There are limited funds for basic research. This applies to all departments, however this especially hurts the smallest ones.
DEPARTMENT OF ELECTRONICS

1. Overview

The Department of Electronics features a good level of research identity and organization. They operate in four distinct research areas: Electromagnetics, Electronic Materials and Manufacturing, Personal Electronics, and RF Technology. They deal with significant state-of-the-art problems (wireless sensors, organics electronics, novel materials, superconductors). There is a very satisfactory funding support encompassing diverse sources. Numerous students and researchers visit leading international research centers. There is good balance in terms of age and gender. It is recommended for TUT to recruit an expert in electronics that could bridge the parts of this department and operate as the mentor for young faculty. Also, young faculty and researchers demonstrate an excellent publication record, although they should be encouraged to demonstrate independent activity. The electromagnetics group should focus on novel challenges such as nanotechnology-based electromagnetic structures that could potentially strengthen its impact.

2. Scientific Quality of the Unit’s Research

Rating: Good International Level (3)

The conducted research has a good balance between theoretical and applied research. Members of the unit are working on timely areas. Their funding from the Academy of Finland has been quite extensive, as well as their Tekes funding. The faculty has very good sense of quality standards. Members of this department have also been involved in editorial and reviewing activities with leading international partners and journals. Some members of the department have publications in high impact journals with a reasonable number of citations. The electromagnetics group performs fundamental research of very high quality. The RF technology group is composed of very highly motivated researchers who have already received international awards and have strong collaboration with leading international institutes.

The department lacks a senior specialist in the area of electronics. It would be very helpful for the students to get trained in fundamental electronics and not just reuse off-the-shelf components and devices. Junior researchers should clearly demonstrate a distinct research path and publication record from the senior faculty before getting considered for elevation to professor status. The novelty of personal electronics and of virtual reality efforts is not clear; both activities seem to mainly serve industrial mandates and should focus more on originality and academic value. Electromagnetics activities deal mainly with fundamental research, but they could be better integrated in the overall department activities by extending their computational efforts to new challenges in the areas of nanotechnology and bioelectromagnetics. The department should target an increase in the level of conducted fundamental research in this area and target rewarding publications in high-impact journals such as Nature. TUT management might consider increasing the visibility of the
electromagnetic group, e.g., changing the name of the department to “Department of Electronics and Electromagnetics”.

3. **Scientific Impact of the Unit’s Research**

Rating: Good International Level (3)

The faculty have joint refereed journal publications with international researchers. They have also initiated and organized international workshops and conferences. Members are serving on editorial boards of international journals. The research funding has been extensive and stable.

There is no participation on editorial boards of high-impact IEEE/ACM communications journals. For academic positions, doctoral graduates are mainly recruited from TUT. It would be good to get the doctoral alumni to work at other universities to increase the visibility of the department. As indicated previously, some labs should focus more on publishing in higher-impact journals, which can significantly increase the scientific impact of the publications. Research funding from the EU is relatively low and seems to have decreased significantly from 2006 to 2010. Superconducting area suffers from lack of support for experimental setup verification. More attention should be paid to fundamental research to achieve publications in high-impact journals, such as Nature.

4. **Societal Impact of the Unit’s Research**

Rating: Very Good International Level (4)

There are several collaborative projects with industry, with a very good level of funding from industry and Tekes. The idea of the Bonita showroom is very good for the industrial visibility of the group’s efforts. Also, the award-winning effort on the paper-roll monitoring RFID solution demonstrates the capability of this department for a significant societal impact. MSc and Doctorate theses projects are based on industry projects and are jointly co-supervised by industry partners. Entrepreneurship is present with patents and spin-off companies founded by employees of the department.

5. **Research Environment at the Unit**

Rating: Good International Level (3)

The environment has a strong diversity in terms of gender, origin, and age. The lab facilities and space are mostly very good. The department has also had several international exchanges and visitors.
There is a strong need for upgrading the superconductor infrastructure. Some level of fundamental electronics lab would be essential for the future of the department, especially in the area of sensors and printed electronics. There are several papers published in joint authorship. This testifies that there is a good grade of collaboration. However, in view of a future career, young researchers should also be encouraged to produce journal articles in which their contribution can clearly be identified.

6. **Future Potential of the Unit**

Rating: Good International Level (3)

The members are very motivated and full of potential. They understand the issues and they have solid plans that will help them improve the impact of their research work, including plans to increase inter-departmental and international collaborations, some of which are already underway.

The department needs to start addressing fundamental problems targeting high-impact journals. They also need to start developing a knowledge basis for wireless sensor integration trying to address the issues of energy management and circuit miniaturization. Core electronics is a research area that is missing in the development targets of the Unit.

7. **Recommendations for the Future**

The university should establish at least one tenure track position for a core electronics faculty member.

The faculty should target refereed high-impact journals and encourage integration with nanotechnology-based structures and energy-efficient solutions via inter/intra-departmental collaborations.

The department should focus on increasing the level of funding from sources that do not depend heavily on industry, which would allow them to perform high-quality long-term basic research.

There are several papers published in joint authorship. This testifies that there is a good grade of collaboration. However, in view of a future career, young researchers should also be encouraged to produce journal articles in which their contribution can clearly be identified.

TUT management might consider increasing the visibility of the electromagnetic group, e.g., changing the name of the department to “Department of Electronics and Electromagnetics”.

DEPARTMENT OF SIGNAL PROCESSING

1. Overview

The Department of Signal Processing is the strongest department in the Faculty of Computing and Electrical Engineering at TUT in several aspects. It has a large and very active faculty spanning many research areas in signal processing.

2. Scientific Quality of the Unit’s Research

Rating: Very Good International Level (4)

The quality of research of the unit is overall high. The faculty members are actively engaged in the forefront of research problems in multimedia signal processing and signal processing for systems biology. Part of the research is driven by long-term research goals and strategic vision. The unit is active and productive in publishing, and results of their work are regularly published in the top journal publications in the field. Some of the work is outstanding and there is a reasonable balance between theoretical and applied research. There are also some weaker activities. The relatively recent and already successful expansion into the area of computational systems biology is timely and relevant, and demonstrates the future trend of the department.

3. Scientific Impact of the Unit’s Research

Rating: Very Good International Level (4)

The scientific impact of the department's published work is recognized by the scientific community. This is reflected in the number of paper awards, patents, editorial positions, and societal fellowships of members of the department. The scientific impact could be raised further by focusing exclusively on the top journal publications and increased visibility in the top conferences. Moreover, the scientific impact of the unit would benefit greatly from closer collaboration – including joint research projects and placement of graduates in postdoctoral fellowships – with the best signal processing research groups around the world. Further, the computational biology group, like similar researchers in the field of signal processing in systems biology, must make an effort to have an impact on both health sciences and engineering.
4. **Societal Impact of the Unit’s Research**

Rating: Very Good International Level (4)

The societal impact of the department is commensurate with many very good signal processing units. The close collaboration of the department with local industry allows their work and graduates to have a real impact on commercial products and to foster the creation of spin-off companies. Equally important, the department produces a large number of well-trained graduates that are important for the local industry. The computational biology group has considerable potential to have an impact in biology and medicine, but would gain from closer local collaboration with biologists and medical personnel (possibly in a joint program with the University of Tampere).

5. **Research Environment at the Unit**

Rating: Very Good International Level (4)

The research environment of the unit is very good. One important positive aspect is the internationally diverse composition of the faculty. The faculty and students are excited about their work and deservedly proud of their accomplishments. The large size of the unit has helped the department reach a strong academic stature both at TUT and around the world. However, the size of the department is also a hindrance to collaboration and joint research in the department as well as an increased administrative load. It is possible that an annual student workshop highlighting the departmental research would promote additional interaction and collaboration among students in the department. The department has benefitted greatly from the international exchange program, which has increased its visibility and the flow of ideas and experiences. The planned tenure track system is very welcome and an important step in the potential growth of the department.

6. **Future Potential of the Unit**

Rating: Very Good International Level (4)

The department has a bright future and the potential to improve further. The department is already considered among the leaders in multimedia signal processing and one of the best places in the world in the area of signal processing for systems biology. Strong leadership and vision could propel the department further to achieve a status of being among the best departments in signal processing around the world.

7. **Recommendations for the Future**

The department has made enormous progress over the past two decades and achieved a prominent place in the signal processing community. Nonetheless, the reputation and impact...
of the department could be further increased with strong leadership and institutional support. First, greater attention to publishing exclusively in top journal publications (even if at the expense of the number of publications) would continue the positive publication trend of the department over the past two decades. Second, a greater and more dominant presence in the top conference venues would also help cement the unit’s reputation. Third, additional emphasis could be placed on leadership in the scientific community in the form of editorial positions in the top journals and organization of the top conferences. Fourth, the unit’s reputation would benefit from closer collaboration with the very top research groups around the world (e.g. MIT, Berkeley, EPFL, etc.). Fifth, the unit should encourage its students to pursue postdoctoral fellows in top research groups around the world as well as academic careers in strong research institutions. Sixth, the systems biology work in the department would have a greater impact if its publications were targeted to both the biological and engineering communities. Seventh, the signal processing for computational biology would benefit from a joint program (as a separate unit) with biologists and medical personnel possibly in cooperation with the University of Tampere. This effort should focus on permanent and local interaction with biological and medical research staff, and complement the current international collaboration efforts with researchers in other institutions around the world. Eighth, the number of students and researchers is very large and the existing faculty has difficulty coping with the increasing size of the department. Future hiring efforts should strive for the highest quality researchers who bring important new ideas and background that complement the current research group. Keeping TUT graduates as Postdocs for later hiring as faculty members is not a healthy practice and should be avoided. The switch to the tenure-track system is an important development that has the potential to improve future recruitment and promotion practices. In summary, it is important that the department aim very high in the future and relentlessly pursue top quality including in the choice of research projects by aiming for ambitious rather than incremental work. Non-industry driven research should be strengthened to complement existing efforts, and the department should aim to lead rather than follow research trends in signal processing.
DEPARTMENT OF SOFTWARE SYSTEMS

1. Overview

The department is a heterogeneous composition of three areas (software engineering, theory, human-computer interaction) with relatively little interaction or synergy. The quality and impact of the groups and projects is very mixed.

2. Scientific Quality of the Unit’s Research

Rating: Fair International Level (2)

The small theory group has some high impact work that is highly cited. The largest, software engineering segment seems heavily influenced by years of focus on industry-driven work with a higher development than research component. Thus, the overall scientific quality is very mixed and in parts weak. There are however, some notable exceptions including publications in top venues. The recently started HCI effort looks promising and has already produced some very good results published in leading venues in the area. It is truly interdisciplinary in combining expertise in software and social sciences.

3. Scientific Impact of the Unit’s Research

Rating: Fair International Level (2)

Except for the HCI and theory areas there is little participation in the editorial boards of major international conferences. Much of the software engineering work focuses on industry needs and is not published in top venues. A few examples of highly cited work in software engineering exist. The theory work is strong and well-published. The HCI group is the most dynamic and active with participation in top conferences, organization of workshops, and other external activities. The group is collaborating with many units in TUT, and has built a strong strategic partnership with the HCI group at the University of Tampere.

4. Societal Impact of the Unit’s Research

Rating: Very Good International Level (4)

The department fulfills an important role in educating and producing software engineers for the local industry, and all graduates not only get hired quickly but already pursue their Master’s thesis research in companies. The department also has been successful in attracting considerable company or Tekes funding for research with industry. Also notable are the two spin-off companies within the last five years.
5. **Research Environment at the Unit**

Rating: Fair International Level (2)

The facilities of the department are very good and the department has a history of attracting industry and Tekes funding but no EU support. There are several problems with the current environment. There seems to be little sense of unity or identity in the department, there is a lack of leadership and direction, and the overall mood appears negative, due to several issues. One problem for the research is the strong demand for software engineers which creates little incentive to pursue a PhD. Due to the funding situation, it is hard to start new research directions. One option would be Master's thesis research, which, however, is often conducted in industry. There is little industry interest in theory, thus it is hard to find funding as well as to attract students. Also, there is no consistent publication culture that aims for top venues. The unusual composition of the department with few disconnected computer science disciplines also contributes to the problem. A notable exception is the HCI group, which is in its direction unique in Finland and seems to be on a promising and dynamic path of growth.

Another structural problem is the lack of diversity in a faculty that almost exclusively consists of Finns, half of which were trained at TUT. There is no tenure-track system. There seems to be a large teaching load, even for some PhD students.

6. **Future Potential of the Unit**

Rating: Fair International Level (2)

The above, mostly structural problems have a negative impact on the future potential of the department. Another factor is the negative development at Nokia, which was a strong industry partner in the past. A positive factor are two projects from the Academy of Finland, which, however, are too small-scale to compensate. In software engineering there is no longer term research vision or strategy. In the current collection of research projects, some are interesting, others appear weak. The future of the HCI group seems bright due to the timeliness of the area, its uniqueness in Finland, and the good setup of the group. The future research potential of the theory group is very good and some strategies need to be adopted to strengthen this group in terms of student recruitment and funding.

7. **Recommendations for the Future**

To improve its research activities, the department should leverage its best work, find partners and apply for EU funding. Postdocs should apply for EU fellowships. Fewer Master’s theses should be conducted in companies. A small amount of seed funding, competitively distributed, could be provided by the university for good research ideas that have no chance of industry funding. Further, the faculty should find international collaborators with strong focus, and, more generally, improve international exchange and visibility. Examples include a (smaller) exchange program similar to the one in signal processing and more participation in international conferences. The publication culture in the PhD program should emphasize
publishing in top venues, even if this means less publications. PhD students should be recruited internationally, and one should more actively compete with Helsinki through advertising and personal recruitment. This department would likely benefit from a structural change, either through fusing departments (discussed elsewhere), through hiring faculty in computer science areas currently not present, or more radical ideas such as fusion with computer science at University of Tampere. Future faculty hiring should emphasize diversity and import of new ideas and background. The university should analyze the teaching load of the department, and if too high, remedy the situation.
PORI UNIT’S RESEARCH IN ELECTRONICS AND INFORMATION TECHNOLOGY

1. Overview

The unit is focused on a multi-disciplinary education and research effort that provides a valuable service to the local community. The collection of distinct and wide-ranging education and research areas in a small unit does not foster strong collaboration and the overall impact of the unit does not reflect the contribution of its individual members. Future efforts should be aimed at transforming the unit into a more cohesive interdisciplinary education and research program with a focused mission oriented towards the needs of the current and future industry and economic vitality of the local region.

2. Scientific Quality of the Unit's Research

Rating: Fair International Level (2)

Researchers have produced refereed articles in international journals and conferences. The department has good research groups in Electronics Materials and in Biomedical Signal Processing and Modeling with cited publications.

The scientific quality of the unit is uneven among the different research groups. Further, the overall quality suffers from a lack of focus, which leads to a perception that the unit’s quality is weaker than the quality of individual researchers. This is the principle weakness of this unit and must be addressed in the future. The department should target publishing in higher impact journals and conferences. There is currently no critical mass in any area; instead of diluting resources, there is a need to define and focus on a single thrust area. There is currently very little collaboration among researchers in the unit. There is a heavy emphasis on applications of known methods driven mainly by companies. There is a need to foster more creativity and pursue fundamental research that is not necessarily linked to industry. The unit’s research achievements are modest.

3. Scientific Impact of the Unit's Research

Rating: Fair International Level (2)

Members of the biomedical signal processing and modeling area have joint journal publications with international researchers and are participating on editorial boards of international journals. Members of the software engineering group are participating in standardization activities. Members of the mobile applications and learning games group are serving on editorial boards of international journals. Members of the department are active in the organization of international conferences and workshops as well as partners in international research networks and projects.
The scientific impact of the different research groups in the unit, like its perceived quality, is uneven and suffers a lack of focus. A major reorganization and focus on a primary research area would help elevate the scientific impact of the unit. The impact of most publications (as measured in terms of the number of citations) is low. The researchers of the unit should focus on publishing in high-impact journals, which can significantly increase the scientific impact of its publications. The participation on editorial boards of high-impact IEEE/ACM journals is low. The research funding from the EU is negligible. Moreover, there is a significant decrease over the past year in industry funding, which is surprising given the focus of the Pori Campus on industry-oriented research.

4. Societal Impact of the Unit’s Research

Rating: Very Good International Level (4)

The unit provides a valuable education service to the local industrial community. The societal impact could be further improved by synergy between a strong research environment in a particular area, which is of vital importance to current and future industry and the economic vitality of the region, and the local industry. The unit is engaged in collaborative projects with industry with funding from industry and Tekes. The software engineering group provides a service to companies through training, consultation, and development based on companies’ needs and participates in standardization activities. Interactive learning tools are developed and deployed in educational institutions by the mobile applications and learning games group. Spin-off companies have been founded by the Mobile Applications and Learning Games group. Further, the Pori Campus participates in the development of regional strategies and action plans.

5. Research Environment at the Unit

Rating: Fair International Level (2)

Very good lab facilities and space are available and additional resources have been provided by industry partners. The environment has the potential to foster multi-disciplinary projects. There is a relatively high number of administrative support personnel.

The research environment suffers from a lack of focus on a particular research area and the absence of a critical mass of investigators devoted to a specific research area due to the diffused research effort among the current faculty. The number of visiting researchers from international institutions is relatively low and should be increased. The number of interdisciplinary research projects conducted is low despite the multi-disciplinary environment and goals of the unit. The number of researchers working in any specific research area has not reached critical mass.
6. Future Potential of the Unit

Rating: Fair International Level (2)

The future potential of the unit could be very promising provided that proactive measures to enhance the research environment and impact are improved. In particular, the presence of strong industrial partners in the region and a municipal government that supports interaction between the unit and the local industry holds the promise for successful future development of the unit. Members of the Pori Campus plan to develop strategies for attracting talented students and are looking into possibilities of admitting international students and recruiting senior research staff from abroad through the FiDiPro program. The unit is aware of the need to target a higher level of scientific research by extending the scope of problems arising from industrial collaborations.

The Campus's research activities should not focus exclusively on short-term needs experienced in the region. Members of the unit should aim for research excellence in topics that has the potential for long-term impact beyond the local region and establish themselves as leaders in their areas. This would increase the visibility and impact of the Pori Campus and may attract other industries to the Pori region, who may wish to recruit well-trained students.

7. Recommendations for the Future

The unit provides a valuable multi-disciplinary education service to the local community, which should be maintained and enhanced in the future. The research effort of the unit, however, would benefit from a substantial reorganization. In particular, the unit should develop a focused concentration on a specific research area of importance to current and future industrial efforts and the economic vitality of the local region and aim at establishing a center of excellence in a specific strategic area. The number of faculty members engaged in research in the unit's primary research area should be increased to reach critical mass to develop a fertile and productive research environment. Furthermore, the unit should aim to enhance joint collaboration efforts both within the unit as well as with various research groups in TUT, Finland, and other parts of the world. For additional details, please refer to the detailed recommendations in the previous sections.