Aalto University School of Engineering
Scientific Advisory Board Meeting
February 23rd -24th, 2012

27th February 2012

Preamble

Aalto University has set itself an ambitious agenda to become a world-class university by 2020. The Scientific Boards of the Schools, nominated in 2011, will support the development of the university towards this goal. The tasks of the Advisory Boards are

- to follow, evaluate and support the research, artistic and teaching activities of the Schools (with focus on research activities),
- to give recommendations on new directions, openings and development activities of the Schools, and
- to evaluate the impacts of the development actions

The Board of the School of Engineering includes the following members

- Professor Torgeir Moan, Norwegian University of Science and Technology, Chair (Marine Structures)
- Professor Luca Bertolini, University of Amsterdam (Urban and Regional Planning)
- Professor Nick van de Giesen, Delft University of Technology (Water Resources Management)
- Professor Philip de Goey, Eindhoven University of Technology (Mechanical Engineering, Combustion Technology)
- Professor Rafael Sacks, Technion - Israel Institute of Technology (Information Technology (IT) in Construction)
- Professor Huseyin Sehitoglu, University of Illinois at Urbana – Champaign (Mechanical Science and Engineering, Fracture Control)

The Scientific Advisory Board visited the School during 23-24 February 2012, with the agenda shown in Appendix A. As background material, the SAB received copies of descriptions of the School and its Departments. The material included

- The Roadmap 2020 of the School with its Implementation Plan of the Aalto University Strategy,
- Facts and numbers of the School of Engineering including one-page descriptions of each department,
- The Research Assessment Exercise Report of 2009 and the Bibliometric Report 2003-2007 including the assessment of the departments of the School of Engineering; included was also an updated publication analysis of the departments (2012)

- The strategy of Aalto University (2011)
- Some general instructions on the tasks of the SAB, the meeting agenda and CVs of the School staff participating in the meeting

During the meeting, the SAB were given presentations about the school, highlights of its research and overviews of the departments.

- Presentations of the School Highlights
- Presentations of the Departments

It must be stressed, that the documentation of the school and the presentations only give an overview of the school, and that the SAB had little chance "to go behind the scene" and get to know the departments thoroughly. The SAB was also given limited time to prepare the report. For this reason we reviewed the draft over the weekend following the visit and submitted this final version on Monday, February 27th.

With regard to the research activities, we consider this meeting an interim follow-up at the School between Research Assessment Exercises. Since only half of the SAB members were involved in the RAE2009 (Moan, van de Giesen and de Goey), the SAB meeting also involved establishing the SAB as a team with a common reference.

We hope that our praise and critique reflect our respect for the significant organizational efforts undertaken by Aalto University, its School of Engineering and Departments, as well as especially its faculty and staff.

Introduction

Given the fact that the University was established (by merging three existing universities and establishing new goals to become a research university) just two years ago, and the given the benchmark of the RAE 2009 results, we are impressed with the progress made on many fronts toward making Aalto University's School of Engineering world-class by 2020. The notion of guiding your ships by the stars, even if not reaching them, is a healthy one. The courage and ambition of the school and the university is admirable and is, as far as the SAB is concerned, not matched by many universities around the world.

School and departments are aware that they should improve their international visibility and their relatively low rate of generating PhD theses, journal papers and low citation scores. Publication rates seem to be growing already, but it is too early to confirm real changes since 2009. Some departments are struggling to improve the publication culture, but the first attempts are clearly visible. Efforts also seem to have been initiated to improve the efficiency of PhD studies and hence PhD thesis production.

In the RAE2009 evaluation it was mentioned that a clear focus and strategy was missing for a number of departments; this is improved and all departments now have focus points. On the other hand, the focal areas seem to be maturing and some are not fully aligned with themes on the school level or university level. This needs extra attention and is the basis for granting needed tenure track positions in the departments.

Although the implementation of the tenure track system for faculty seems to be well underway, there are unresolved issues regarding allocation of positions, recruiting processes that ensure high quality applications, etc. that need to be further developed. The use of the sabbatical system and the presence of foreign faculty, researchers and students at the Aalto University is intimately linked to international recruiting and requires continuous focus.

We especially encourage all tenure track and tenured faculty to take sabbaticals outside of Finland, with preference for stays at departments with strong research in each faculty member's field.

Strategy

In a relatively short time strategies for the University, the School and its departments have been defined. Moreover, university and school wide initiatives and development projects of different kinds have been established. These plans, involving e.g. energy, sustainable industry and society etc., to a large extent reflect international trends. It seems that the departments in the School of Engineering have research plans that more or less fall within the main programs for the School (Multidisciplinary energy technologies, Digitalization in engineering, Computational modelling and systems thinking, Materials technology, Sustainable society).

In order to become world-class, Aalto University and the School of Engineering must focus on specific research areas in which they have or can develop strength, based on possible competitive advantages offered in Finland, unique competence and infrastructure at the Aalto University etc. It then could start within research niches, but later expand and include others. A crucial issue is the mechanism for identifying, prioritizing and development of these focussed research areas. This must be both a bottom-up and a top-down process, with continuous discussion, both vertically and horizontally, e.g. between the professors and other key persons within their departments, the leadership of the school and the leadership of the university. This approach is crucial in making Aalto excel in interdisciplinary research, including the synthesis required in design and planning. Since high quality interdisciplinary research needs to be based on high intradisciplinary quality it is also important to include international alliances to

reach these goals. No single university would have top complementary quality in many disciplines.

Moreover, it is important that there is room for researchers who do not follow the main trends, but excel and (therefore) are the ones that come up with the breakthroughs in research. Such persons could very well be the stars in the Aalto University, as experienced in many other universities.

The RAE2009 reports mentioned the need for more basic research. However, the distinction between 'basic' and 'applied' research is no longer sharp or functional in modern research. Developing knowledge to address societal needs requires continuous iteration between 'basic' and 'applied' research modes. All departments should be aware of this and should strive at a healthy mixture of funding sources for research. A complete shift to 'basic' research would be difficult to make and not even desirable since it could destroy important existing relations with industry and society - for funding and the necessary inspiration for basic research in engineering science. On the other hand it is desirable to establish more long-term *programs*, and not only fragmented *projects*, supported by industry and other societal partners (e.g. local government).

The challenge for any engineering school is to draw new knowledge from their research activities, whether it is basic or applied in its stated goals. Thus professors should strive to define what could be learned at a basic level within the context of industrially funded research projects. When initiating industrial research projects, professors should determine whether the project will be of use in meeting their fundamental research curiosity, and tailor the project definition and funding, to the extent possible, to ensure that they will achieve publishable results from it and allow PhD students to develop a thesis within it.

Key performance indicators (KPI) should recognize this variety of research modes. We support Aalto University's quality indicators: publication quality, excellence or competitive grants, awards & recognition, interdisciplinary projects, invited lectureships, quality of applicants. Moreover, it is important that the School and its departments contribute to establishing KPIs that include indicators of scientific, innovation, teaching and societal impact that are appropriate to each area. Most engineering schools in the world struggle with science-based evaluation metrics but the burden is on us to develop credible additional KPI's that help distinguish a good engineering school from a not-so-good one. For example, the indicators of quality discussed in Section 4.8 of the Road Map (page 16) do not mention innovation. Indicators of interdisciplinary or cooperative work are also important, especially in view of the profile of academic work at Aalto University.

Although we acknowledge the limited information at our disposal, our impression is that the strategic plans of the different departments are still too vague. They seem to indicate that the departments are aware of the suggestions made by the RAE2009 reports. Existing problems are mentioned to be

addressed, but it is unclear **how** improvements are to be accomplished. This aspect is not substantiated and is largely missing. For example:

- How will they become recognised in the world?
- How will the quality rise?

There is also room for greater collaboration within the school – potential synergies exist for aligning research with the university's strategic goals through interdisciplinary work.

PhD Programme

Educating PhDs is a prime indicator of a leading university. This appears to be an opportunity for focussed effort in the School of Engineering.

Strong preference should therefore be given to full-time PhD students over part-time PhD students. Part-time PhD students reduce the focus of their advisors and distract them from the core productive work. At the same time, those part-time PhD students who are retained should be also encouraged to engage in publishing papers. In statistics provided concerning PhDs, we recommend distinguishing between full-time students, part-time students who are seriously pursuing their thesis work, and people who are PhD students in name only. Completing a thesis in a given period of time is in itself a measure of quality. The university's performance appears inadequate if the number of annual graduates is too small a fraction of the total number of registered PhD candidates.

The structure of doctoral studies should be further developed in terms of formulating and implementing a research plan, within one to two years after start, that has the potential to achieve publishable results within reasonable time frames. Monitoring should filter candidates early, to avoid long durations for PhDs. Topics for a possible research school could be to strengthen the offered courses on research methodology, quality of research papers, publishing culture etc. Probably further efforts could also be made in strengthening the supervision and maybe consider requiring a minimum of 2 supervisors and periodical external reviews for each candidate to ensure more robust supervision.

Time periods for finishing PhD work are exceedingly long and not much improved since RAE2009, although all departments are aware of this problem. It is advised to look for ways of funding complete PhD positions of 4 years to improve the situation. In Engineering this is a challenge. It may be difficult to improve the situation seriously within short notice in the Engineering School, as part of the financial support is related to short term TEKES projects, which are difficult to use for full-term PhD positions. It seems also worth discussing this matter with TEKES and others, in order to explore the possibility of developing funding mechanisms that *both* meet the short-term output requirements of

industry *and* the long-term continuity requirements of a PhD project. In other countries there are already interesting experiences in this respect.

Research groups

It is recommended in the Roadmap document that an ideal research group has a pyramid structure. In some countries this includes a hierarchy of professors, other researchers/postdoctors, PhD candidates. In Aalto University the idea seems to strictly let individual (assistant, associate and full) professors to be responsible for the success of their (small) research group. On the other hand, it is crucial to organise research to exploit synergies through joint projects etc. This is not least important to provide a healthy research environment for PhD candidates. Closer interaction also effectively implies more robust, more sustainable research units. To promote synergy it is important that researchers are organised to experience the improved performance by cooperation with mutual benefit, Moreover, cooperation or mentoring could be stimulated by e.g. including a KPI that relates to such issues.

The utilization of postdoctoral researchers to meet research milestones and to interact with graduate students and faculty is commendable. We recognize that postdoctoral students can be utilized to increase the rate of publications of the departments and could potentially represent a pool to draw from as potential tenure track faculty. Aalto's reputation will also be elevated if these postdoctoral candidates find academic positions in other institutions, hence it is important to pay attention to mentoring and intellectual growth of these postdoctoral candidates.

Tenure-track Recruitment

The School of Engineering Road Map correctly identifies recruitment of tenure-track professors as the cornerstone of the university's plan to meet its goals. However, the goal of 75 tenure-track academics by 2020 requires recruiting 63 people (only 12 of the current professors will remain) within eight years. This rate, of eight people per year, is at once:

- a unique opportunity to redesign the school and its focus areas for research excellence,
- a threat, if not achieved or not done with care,
- a major challenge for the leadership of the school and the departments.

We feel that it cannot be achieved in the traditional approach of advertising and interviewing, because the cycle time for recruitment is too long. A specific tactical approach will be needed to accelerate the process. A competitive start-up package for newly appointed professors is essential for recruitment, in view of the international competition.

The tenure track positions requested by the departments seem not to be entirely in line with the focus points of research and are in some cases based on pragmatism (how to fill in positions of retired professors). While we acknowledge that we may not have all of the information, and that the process is dynamic, we feel that there should be more consultation within the School to result in a clearer message from the school to the university administration.

Use of visiting or adjunct professors could be helpful in overcoming some of the significant recruitment challenges. It also offers closer contact with some international university environments and could be a network that can be an element in recruiting permanent faculty members.

Departments

Department of Energy Technology

- The focus areas (energy efficiency, decentralised production and combustion technology) are interesting and along the lines of the strengths of the department; energy efficiency is clearly an Aalto based strategic line of research in which the department (and School) could take the lead and is very promising. The other two focus areas are related to the focus areas of the School.
- Tenure track positions in Energy systems for Communities, Applied Thermodynamics and Power and Heat Production Technologies are not clearly linked to the three mentioned focal areas. Clear explanations of the connections should be given which is the basis of a more clear strategy.
- Some progress has been made since RAE 2009 regarding doctoral training, some rudimentary forms of doctoral school seems to be in place.
- There is a clear attention for journal publications. The number of scientific publications seems to be increasing and the publishing skills are improved by offering courses to students and assisting each other.
- New initiatives have been introduced in the department to collaborate with other European research institutes to strengthen the basic research, which adds to the international visibility of the department on a longer term.
- The groups within the department are small and contain one professor, giving rise to 10 groups, this is a drawback to improve synergy in the department. The synergy with other groups such as in the Fluid Mechanics area with Department of Applied Mechanics could be a way to emphasize existing strengths and collaborations.

Department of Engineering, Design and Production

- The department has 3 focal areas (Digital Engineering, Engineering Materials and Ecological Mobility). The focus area on Engineering Materials is clearly linked to the School theme on Material Technology. The focus point on Ecological Mobility is linked to school theme on Sustainable Society. The focus area of Digital Engineering has a clear connection to the school's focus on Digitalisation in Engineering while the term is somewhat misleading and a better term should be in place. Furthermore, digitalisation is more like a tool than a focused discipline.
- The 2011 tenure track position in History in Industrialisation is not clearly linked to these focus areas, while the position on Advanced Joining Methods is closely related to the Engineering Materials area. Clear

explanations of the connections should be given which is the basis for a more clear strategy.
- The group on Engineering Materials appears to have a strong set of experimental facilities and publication record.
- Some progress has been made with doctoral training, by for instance organising a scientific methodology course for doctoral students and a monitoring system in supervision is established.
- There is a clear attention for journal publications. The number of scientific publications seems to be increasing and several incentives are started to improve the publication culture (as mentioned in the strategic plan, but not explained further).
- (groups within the department are small and contain one professor, giving rise to 9 groups, this is a drawback to improve synergy in the department)

Department of Applied Mechanics

- The department has focal areas for their scientific foundation on Computational Solid and Fluid Mechanics, while common themes are Arctic Technology and Advanced Lightweight Constructions. The majority of applications are related to Marine Technology (and to a lesser extent Aeronautical Engineering). The strength in selected fields in Computational Solid and Fluid Mechanics is recognised but the link of the focal areas of the department with school themes and Aalto themes is not obvious and should be clearer.
- The 2011 tenure track positions in Aerodynamics and Marine Technology are based on major application areas of the department but not clearly linked to the focus areas or the focus areas of the school or Aalto level.
- The department is leading the planning of an Aalto initiative on Arctic Technology.
- The department is in serious need for fast follow-up of tenure track positions replacing retirements. The utilization of part-time international faculty to support existing efforts in solid mechanics should be commended.
- Doctoral training is somehow in place through a graduate program (the funding of which seems to end soon).
- There is a clear attention for journal publications. The number of scientific publications seems to be increasing.
- The department is running several large-scale facilities for model testing which are unique but are expensive. Although these facilities permit unique experiments to be carried out, we are concerned that these facilities consume too many resources at the expense of scientific endeavours. Hence the organisation of the operation of these laboratories should be re-evaluated. One alternative might be to operate the most unique facility (the ice tank, possibly extended with other features)

directly by the university and operate other laboratories as a commercial unit.

Department of Civil and Structural Engineering

The department has presented a very clear strategy that pinpoints two areas for building focused research competence: Building Materials Technology and Building Information Modeling (BIM). The recruitment plan that derives from this prioritization calls for four and three professors in each area respectively. The goal to achieve a critical mass of researchers in the area of BIM is particularly ambitious, given that this area is new to the department, yet the progress made in recruiting two tenure-track professors is a sign that the effort is on track.

The list of the most important research topics identifies important topics, but it is too detailed to form a vision that can be implemented. It appears in part to reflect existing interests of the members of the faculty, but it will need to be flexible and changed through time. The focused research groups will need to respond to developments in the state of the art and to the progress that will be made in practice. This demands leadership at the department and the school level, to keep a finger on the pulse of the research, ensuring that these topics are reviewed periodically. This is necessary because research effort that is centered around teams of three or four professors requires a conscious effort of coordination to maintain their critical mass.

Thus, the list of topics should be narrowed, but it could also be tailored to fit better with the broader university research priorities, with particular emphasis on energy efficiency. Both the Materials and BIM groups can contribute significantly in this area.

This department carries an inordinately large part of the teaching load in the school (in terms of BSc students), and this means that it must maintain capabilities in areas that are relatively mature in research terms, such as structural engineering. The recruitment plan recognizes this and appears to be sound.

The initiative to give students flexibility in determining their degree programs is novel and commendable. It should be monitored carefully. One concern is the impact it may have in changing the distribution of teaching loads in ways that increase the teaching load.

Civil & Environmental Engineering and Surveying & Planning

Both departments are newly formed by recent mergers. Both seem logical and potentially very strong combinations. Still, it would be good if the natural links within and between these two departments are further specified and developed. This is essential to achieve the 'focus and mass' that is required to be world-class. For this reason we discuss these two departments together, without implying that there should be administrative changes.

We appreciate that some of the research in these departments is already world class. We only received a very limited amount of information but the highlighted work on water engineering and surveying looks for instance very good.
A background for seeking 'focus and mass' could be based on the following notions:

1. The notion that solving complex societal problems (such as sustainable development) requires linking research in technology and in society
    - Technology = potential technical solutions (e.g. as researched in environmental, water, transport engineering)
    - Society = socio-economic trends, political processes (e.g. as researched in planning)
2. The notion that most complex societal problems have, importantly, also a spatial dimension (i.e. the distribution in space of resources and impacts)
3. The more general notion that, for both research and society to thrive, research results need to find a way into society and societal problems need to find their way into research.

Elements of these notions can be found in the strategic plans but could be more guiding with respect to creating synergies within the departments, between departments, within the university, and internationally. They would also help the "emancipation" of engineering science in the context of Aalto.

- Related suggestions
    1. Look for project based synergy between water engineering, environmental engineering, transport engineering, surveying, land use planning (the joint Masters of Managing Spatial Change could show the way and provide a testing bed for potential collaborations)
        - In particular, the fields of Transportation and Land Use planning could be more closely connected, and tenure track appointments should reflect this potential

- GIS & Watershed management seem also a very logical combination that can be supported by new appointments

2. Link research in surveying and land use planning to research in all other fields, to acknowledge the integrated technical, social, and spatial dimension of environmental issues
3. Keep looking for ways of translating research results in useful knowledge for decision makers. For instance link digitalization in engineering to sustainable society research to realize Decision Support Systems/Planning Support Systems (e.g. by coupling GIS and planning)
4. In particular, the departments could be leading in the school theme "Sustainable society", while at the same time improving cooperation with Energy Technology.
5. At the University level, especially the Aalto-wide theme "Human Centered Environment" is a natural rallying point to define collaborative projects involving the two departments.
6. The link between spatial information and behaviour will become more and more influenced by new technologies, which offers interesting perspectives for exciting science across campus.
7. Some of the tenure track positions seem to point more towards these integrative challenges and opportunities than others. Prioritization should reflect the future point of emphasis in this department in this respect.
8. Finally, achieving more synergy is essential. However, we advise not to force artificial collaboration, but rather actively facilitate bottom-up networking, while acknowledging that deeply engrained cultural differences require time and experience to be overcome. Projects, with a clear lifecycle, tend to be the natural vehicles to foster productive cooperation.

As a last point: the name of the "Surveying and Planning" correctly reflects the historical development, but from an international perspective does not convey the visibility it deserves. Something that suggests the broader role of space is recommended.

Appendix A. Visit Agenda Feb 22-24, 2012

Aalto University coordinator Dr. Greger Lindén and ENG coordinator Ass.prof Jan Romanoff coordinate and support the SAB during the visit.

Wednesday 22.2 2012
19.00 Dinner (Radisson Blue Hotel Espoo, Dean Petri Varsta, Vice Dean Juha Paavola, Ass. prof. Jani Romanoff)

Thursday 23, 2012

0900-1015	Introduction to ENG and to ENG activities Aalto University, Management and Services, Lämpömiehenkuja 2, Meeting Room: Alvar, Aino, Elissa	SAB, Dean Petri Varsta (PV), Vice Dean Juha Paavola (JP), Ass.prof. Jani Romanoff (JR), Senior Adviser Greger Lindén (GL)
1015-1030	COFFEE	
1030-1100	Introduction to Aalto University and the Finnish Higher Education System Meeting Room: Alvar, Aino, Elissa	SAB, Greger Lindén
11.30-1300	LUNCH Meeting with Tuula Teeri, President of Aalto University Aalto University, Management and Services, Lämpömiehenkuja 2, Restaurant Calori, cabinet Nordic House	SAB, Tuula Teeri, PV, JP, GL
1330-1500	Highlights and new openings Building R, Rakentajanaukio 4, Lecture Room R 8	
	- Water engineering	prof. Olli Varis
	- Material technology	prof. Hannu Hänninen
	- Marine technology	prof. Pentti Kujala
	- Human oriented environment	D.Sc. (Tech) Aija Staffans
	- Energy efficiency	D.Sc. (Tech) Mari Tuomaala
	-Co-operation with architects	Vice Dean, prof., Juha Paavola
1500-1530	COFFEE	
1530-1730	Short introductions to departments and discussions with department heads (15 minutes/dept.) Building R, Rakentajanaukio 4, Lecture Room R 8	SAB, Dean & department heads
1730-1815	SAB internal discussion; SAB report discussions and writing Room R 350	SAB; Senior Advisor Greger Lindén
1815	Transport from Building R to Hotel	
1900	Transport from Hotel to Restaurant Nokka	
1930-	DINNER; Restaurant Nokka in Helsinki	Dean & department heads
2200	Transport to Hotel	

Friday 24, 2012

0900-0930	Future directions; Discussion with Dean and Vice-Dean Meeting Room R 350	SAB, PV, JP, GL
0930-1200	SAB report discussions and writing	SAB, Greger Lindén
1200-1300	Lunch and End of SAB Meeting Restaurant Dipoli	SAB, PV, JP, GL
1300-1400	SAB Chair Prof. Moan discussing with Dean Petri Varsta, Aalto University, Management and Services, Lämpömiehenkuja 2, Maison Carre, 3. Floor	Prof. Torgeir Moan, Dean Petri Varsta, Senior Advisor Greger Lindén
1400-1500	SAB Chair Prof. Moan meeting with Tuula Teeri, President of Aalto and Dean Petri Varsta Aalto University, Management and Services, Lämpömiehenkuja 2, Maison Carre, 3. Floor	