<u>Report of Scientific Advisory Board:</u> March 18, 2012

Issued following the SAB Visit to Aalto-School of Science,

February 16-17, 2012.

Scientific Advisory Board (SAB):

- Professor Rolf Jeltsch, ETH Zurich
- Professor Sir Peter Knight, Imperial College*
- Professor Jan van Leeuwen, Utrecht University
- Professor Arto Nurmikko, Brown University (Chairman of the Advisory Board)
- Professor Georges Romme, Eindhoven University of Technology
- Professor John Shawe-Taylor, University College London
- Professor Claes Wohlin, Blekinge Institute of Technology*

* = unable to attend this SAB meeting

Stated Purpose of the Evaluation (from Aalto University Administration):

- to provide a constructive assessment of the strategic plans and goals of the School and its departments (and, in subsequent reports, a constructive assessment of the implementation and effectiveness of the plans)
- to assess the academic quality of the research achievements, scientific and societal visibility, research environment and future potential of the departments

The evaluations described above are done in order:

- to support and encourage the departments in their activities
- to support the Dean in managing and developing the School and in revising and sharpening the School's strategic plans
- to provide the President with tools for developing the whole University

The reports are utilized by the Aalto University Board in preparing and revising the Aalto University Strategy and in negotiations with the Ministry of Education and Culture.

N.B. This was the first meeting of the SAB. For several members this was a first visit to Aalto Univ. Thus the purpose of the meeting served to get acquainted with the School of Science, its current state of development, and to form a very general first impression of the departments and laboratories of the school. Most attention was given to the current status of the School at the Departmental level. The departments and laboratories were represented by the heads, who gave (very) short overviews of their current focus areas, achievements, challenges and current 'strategic' actions (without site visits). The SAB report is NOT meant to be all-encompassing but rather focus on few specific items on this first SAB visit. A number of other important items are note discussed in this report but are deferred to subsequent SAB meetings.

Executive Summary:

In preparing the report, the Scientific Advisory Board* took note of the fact that Aalto University as well as its School of Science (SCI) are in their infancy when projected against the backdrop of historically well established autonomous (and entrenched) programs in the earlier wholly state-supported separate institutions of the Helsinki University of Technology and other Schools (of Economics and Art&Design, respectively). The Aalto University concept is both innovative and powerful in its promise and potential. At this early stage and viewed through the SAB's visit to the School of Science some encouraging early signs of cultural shifts are visible, at least in the perception that the process of eventual integration of Schools and Programs is put firmly on its track by the Governing Board of Aalto, and being implemented by President Teeri.

Yet unsurprisingly, the SAB experienced a sense that, at the academic level of the School of Science, the larger philosophy of the Aalto University concept appears to be somewhat undigested at the present. On the other hand, the recognition that early plans are under way for example for physically (geographically) to move the other two School of Economics and Art&Design from downtown Helsinki to Otaniemi, and the significant initial success in fundraising, appear to have made a positive impact on the School of Science in raising the general consciousness about the larger Aalto unified construct becoming realized.

As presented to the SAB, the broad strategic plans of the SCI are certainly impressive in their ambition and breadth . The School has stated a clear goal of being `world-class level' by 2020 and wants to be recognized internationally in its core focus areas, with synergistic bridges to economics and art/design. The SCI has some truly superb areas of scientific excellence from which such high aspirations can be launched. Yet, the focus areas in the SCI seem still so dominantly science and engineering oriented that the opportunities and benefits of intersection with the other constituent domains of Aalto appears still to be requiring considerable articulation and advocacy at the SCI. The large size of the SCI relative to the other academic units of Aalto makes this a core challenge to reshape its academic outlook.

The presently constructed SCI is home to 7 departments, 1 laboratory (OVLL), and 1 graduate-level institute (HIIT). In the body of this report we comment on the academic quality of their individual research achievements, scientific and societal visibility, research environment and future potential of the departments, based on the summary information presented to the SAB in its recent first meeting. Here we comment on three School-wide issues that seem to have a common thread of a challenge throughout the departments.

Strategic Vision of the SCI: As noted, the present strategy of the School is necessarily broad. The translation of it into broadly `development objectives' was equally well-stated and clear. However, the development objectives at the departmental level are still lacking clearly defined operational plans and relatively narrow visions for the future, if at all, were evident to the SAB. A specific recommedation by the SAB is that each department be challenged to develop a clearly defined five-year plan: what will concretely be accomplished in this time frame, means and approaches to

achieve them, plan of implementation objective by objective with set targets, and definiton of key success indicators to aim for.

The SAB appreciates that changes required for the Aalto concept to be fulfilled are stressful and push people out of their comfort zone in an established acedemic setting. In case of the SCI, this requires distinctive and forceful leadership at level of the Dean of SCI and by the Department Heads. The present leadership at the Departmental level appeared to the SAB at times to be following the Aalto prescription as a set of given rules: 'ours is not to reason why'. There were relatively few examples where clear enthusiasm for the project shone through. Forceful and visionary leadership can be employed both to initiate actions while convincing a constituency that there are benefits and opportunities for the SCI and its faculty, staff, and most important to the students. The students who will (hopefully) be increasingly the beneficiearies of the Aalto experience will become the leaders of tomorrow.

While the SAB believes that earnest and significant progress has been made in the early phases of the transition in the SCI, we recommend also that multiple additional means for engendering enthusiasm for the Aalto project and importance of the SCI in it should be considered.

Given the finite initial progress that SCI has made in adapting to the Aalto concept, it would therefore be profitable to explore ways for generating more grass-roots enthusiasm within the SCI. Suggestions might be:

- More directed funding from the central administration to prime-the-pump for incentivising the Departments' strategic vision, specifically in the form of targeted new appointments, preferably with international faculty (oddly, during the SAB visit a couple of department heads seem to acknowledge that they already anticipated or possessed such funding – yet had little idea what to do). At the detailed level, the SAB discussed several other ideas such as funding of part-time PhD student for teaching duties.

- Robust co-funding from the central administration for projects proposed by departments that draw on their reserves and develop collaborations with other Aalto schools. Some of this seems to have started; more can and should be none.

Impressions and Commentary on the New Tenure track system:

The newly introduced `tenure track system' is ambitious, but is welcomed by the SAB as both necessary and inevitable for achieving the goal of an internationally recognized faculty with a rational demographic distribution. Transfering some of the existing staff-positions to the new system and entry of first truly new hires from outside the "old HUT" seems to be on the right track. Needless to say, hiring bright young new faculty is key to future – and not an easy one for a country such as Finland.

Procedurally, from the information given to the SAB, it seems that the lead time for recruiting new faculty under the new system is sluggish and needlessly lengthy. Candidates should know within a month or two after an appication deadline whether they have "made the cut", with more rapid interviewing and final selection process. A lenghthy process can lead to loss of the top candidates (or they will simply stop applying if the perception about slow bureaucracy spreads). The SAB recommends a review the current procedures in order to reduce the current lead time.

It is worth reflecting that the 'tenure track' model has two components: first, the appointing of junior academics to positions in which they enjoy full independence to create their own research agenda while on the other hand requiring them to reach a particular high 'bar' of demonstrated quality within a fixed period of time for granting tenure. The SAB firmly believes it is the first component which it is necessary to establish so that the best possible outcome ensues for the latter, while securing the quality and enthusiasm of the young faculty. There should be clear understanding, too, that gaining tenure is a competitive process and by no means an "automatic". Given that the tenure system at Aalto is a new concept within the Finnish academic system, the SAB also recommends targeted young faculty mentoring programs by outward-looking senior members, as part of their engagement and experience with their new institution.

Current Department Structure: Clarity, Overlaps, and Redundancies:

The SAB recognizes that several of the departments within the SCI have undergone structural changes in recent years, some more pronounced than others. At present, and to an outsider be he/she an academic looking for positions or a graduate/undergraduate looking for coherent departmental structures/programs of study, the organization of several departments appears somewhat mysterious. Most notable, the word Computer or Computing appears in no less that three department titles (four, if one implicitly also counts in the HIIT). There may be historically understandable reasons for this nomenclature but, both at the superficial level (i.e. presenting a facade to the outside world) and at the more fundamental level of harnessing the intellectual, research, and educational power of these three departments, the present organization appears to be far from obviously optimal. While commenting on this subject further in the core of the report, the SAB believes that computer engineering/science and computational elements within the SCI should consider, and implement, new strategic alliances amongst each other. This should lead to a more rational design of their departmental structure in the future, including some possible (likely?) fusion.

A somewhat similar situation occurs within the triangle of the Department of Applied Physics, Biomedical Engineering, and the Low Temperature Laboratory. Scientifically, portions of the Low Temperature Laboratory can fall seamlessly within Applied Physics (e.g. in areas of electronic quantum devices) while other portions are scientifically fluent with Biomedical Engineering (e.g. Brain Imaging). It is encouraging to see that the faculty of the venerable (and world famous) Low Temperature Laboratory is now benefiting the SCI also through teaching – yet further integration with the SCI is encouraged.

The SAB also noted structural issues observed around (the newly merged) Department of Industrial Engineering & Management (DIEM) which currently is one of the larger departments within the Aalto SCI. As summarized below (under DIEM), it remained unclear to the SAB as to why DIEM should necessarily be embedded in the SCI. A quite plausible case can be made that DIEM's position in the School of Science (as opposed School of Engineering cf. "Industrial Engineering") or possibly the School of Economics cf. "Economics & Management) because its prevailing research approach is so distinct and different from the scientific methodologies employed in other departments of SCI.

SAB Report: Impressions, Evaluation and Assessment of the School of Science by Individual Departments and Units

In the following, the SAB provides a summary of its observations, impressions, and some recommendations, following the two day visit to the School of Science (SCI) in February. Since two members of the SAB were unable to attend, the summary below has been influenced somewhat by the absence of their expert input. Thus, for example, the Department of Media Technology can perhaps benefit from added input beyond what the SAB can offer in this report. Likewise, while some SAB members had participated in the RAE 2009, others had not, so that this report does somewhat reflect a gradient in familiarity with the Departments across the SCI.

The summaries are compiled In the order of their presentations to the SAB. At the end of the summary, the SAB wishes to note strategically important issues that relate to computing, computational sciences, and computer sciences which presently (and still) appear to remain distributed in a somewhat incoherent manner across several departments of the School.

As noted in the Executive Summary, one sweeping observation which the SAB made across all the Departments was their apparent lack of strategic vision concrete and plans at this time, at least insofar as the presentations by the Department Heads went during our visit. The SAB strongly recommends that the Dean of the School of Science, in close coordination of the Department Heads, urgently address e.g. the formulation of a 5-year holistic and forward-looking strategic plan. Hopefully, the summaries below can offer some assistance to this important task. The SAB will be ready to contribute to the process but does hope that the School and Departmental leadership take the initiative here. In so doing, the SAB suggests that the present leadership also actively embarks on early identification of the next generation of potential leaders for the Departments and the School since the transformation to the full Aalto vision is likely to involve such generational passing of the baton.

Department of Biomedical Engineering and Computational Science

The ”BECS” department was subject to a thorough RAE in 2009. In the subsequent report, the scientific quality of research within the BECS was assessed as being internationally recognized and of very high standards. What follows is commentary on the subsequent time period, with lesser emphasis of the scientific quality/performance per se, but rather on the strategic matters that pertain to the role and structure of BECS when projected against the future of the School of Science and Aalto University.

As presently constructed, the Department of Biomedical Engineering and Computational Science (BECS) consists basically of two distinct parts: the Laboratory of Biomedical Engineering (BME) and the Laboratory of Computational Engineering (LCE). On the one hand, there have been benefits for such a rather unique combination of two disciplines, with significant scientific output. On the other hand, it would seem that the “marriage” of BME and LCE as two subunits is also a result of scientifically powerful forces having been united under a leadership and cross-disciplinary arrangement which may or may not be a useful paradigm as the department and the SCI look ahead.

Accordingly, and from point of view of strategic planning within SCI, it seems evident to the SAB that the BECS as a department will sooner than later be at crossroads related to its future. Time for planning and planting is now. While there are obvious points of symbiosis between the BME and LCE units, the department would do well to investigate what its true technical center of gravity : Is BECS a true Bioengineering or Biomedical Engineering department or not? As one example (see also comments for Low Temperature Laboratory, OVLL), the Bioengineering components which relate to brain imaging, brain science (from OVLL), and computation of complex systems could be viewed as providing the core scientific strength of a future Bioengineering type department. Leveraging on the pioneering, world-class work on development of brain imaging and neuromodulation techniques is a superb asset, for one. In such a model, some of the computational activities which are not necessarily bioengineering or health technology related might consider migration and integration with one of the other computing- or computer science-centric departments.

Citing from the RAE 2009: *"The panel supports the drive for hiring new research staff with expertise that complements the existing ones. We do recommend that the proposed hiring be done, especially on the Laboratory of Computational Engineering (LCE) side, in the context of a carefully defined strategic plan, that takes into consideration projected future projects and research topics. This strategic plan should take into account University-wide long-term strategic planning; for example, if expansion in the direction of Life Sciences is planned, this unit should expand in the direction of Systems Biology, Bioinformatics and Computational Biology."*

At our February SAB meeting, while active and promising hiring of talented faculty seemed to be on its way (three new professor recruitments during 2010-11 and one under way), it was not clear to us how e.g. the above referenced recommendation of the RAE2009 was being either implemented or accounted. That is, there was little concrete evidence presented by BECS leadership as a concrete set of steps to be undertaken in a next 5-year plan.

Some additional comments by SAB members were:

- In the spirit of true synergy, leadership of BECS was unable to identify projects containing all three focus areas: Biomedical Engineering and Biophysics, Computational Complex Systems, Brain and Mind.
- The answer to the question "where do you get the mathematical training" was offered as "using methodological development by ourselves". The answer left the question open as to BECS's perceived the value of the Mathematics Department (and other computational science practicing units)
- The Brain and Mind initiative seem to suggest that there was collaborative activity with the Low Temperature Laboratory – on a limited scale.
- And, again, why use the word computational as part of this department's name. It may not be effective from effective marketing point of view, either

Department of Mathematics and Systems Analysis

The SAB is devoting extra space in this report to the Mathematics and Systems Analysis Department, given the special challenges that this department is facing. The department was subject to the thorough RAE in 2009. What follows is commentary on the subsequent time period, with focus on

the key challenges to the Department especially in terms of its faculty distribution, size, and its heavy teaching commitment to the School.

In the years before the 2009 RAE the two laboratories, Mathematics and Systems Analysis, had been joined to become the department. For some time the two Laboratories held a total of 13 full professors. However, due to two independent events two professors on inverse problems have left for different reasons. A third faculty memeber was ”lost” as his scientific interests had changed. Hence the department was operating only with 10 full professors instead of 13 – a substantial *negative* growth rate.

Complicating matters (unintentionally), Aalto University formally only started January 1, 2010 , and event which delayed the appointment of replacement faculty. In addition, the new tenure track system has been put in place. This again delayed the hiring process until two assistant professors were hired in the second half of 2011. Hence the department is still understaffed.

Unfortunately the faculty age distribution is poor for the future. This is aggravated due to the loss of the two professors in the field of inverse problems. Of the present 12 professors 8 will retire between now and 2019, the two assistant professors are 33 and 34 and only two are in an age bracket between. This could bring the department into very difficult leadership problems. The SAB recommends that with the emerging replacements hiring should target one or two faculty on the level of a ’world leader’ , i.e. mature enough for leadership position.

Citing the RAE report from 2009:
"It is not possible to operate a high profile university without a strong mathematics department including both pure and applied mathematics components – both for the sake of the discipline itself and its pivotal role in educating scientists and engineers."

This has been interpreted by the Mathematics Department, in particular also in view of the large amount of teaching, that the target for the department should be a strength of 24 professors by 2020. The recommendations of the RAE 2009 has been summarized nicely by the Update for the 2012 SAB evaluation as follows:

1) essential growth needed
2) profile should be wider
3) increase the number of foreigners within doctoral students, postdocs and faculty

The SAB supports these arguments and goals by the department for the following reasons:

- There is a heavy teaching load. One can only hire world leading mathematicians if the teaching load is reduced. (Apparently one excellent person has left because of the heavy working conditions.)

- Currently, in addition to the 10 professors there are ”18.7 positions” with teaching obligations and 5 research centered positions. The other departments in the school of Science have much

higher proportion in positions centered around research. It is difficult to attract excellent research scientists to a department which has the image of being service teaching only.

- In other departments mathematics is heavily applied, e.g. in the Department of Bioengineering & Computational Science topics such as complex dynamical systems, modern materials are studied using mathematics, inverse problems are solved, graph theory is used, social behavior is modeled using agent based methods. These departments appeared to suggest to the SAB that they ”know the mathematics themselves”. However for a world leading university it is important that there are also mathematicians who work at the mathematical forefront of these fields. This would improve the output in the other departments at Aalto.

- For the curriculum for students in mathematics it is a must that broadness and quality in mathematics is provided. It is also important the Ph.D. students in mathematics are on a high scientific level.

- There is still to much ”inbreeding”.

With the hiring of the two assistant professors the department was successful to enlarge its scientific base and to hire a foreigner as well as a female. Both assistant professors bring in new fields and new type of applications. The positive trend should be continued.

Proposed Hiring strategy:

1) Selection of areas: The SAB is suggests that new hirings should balance applied and basic mathematics. For an excellent education of the mathematics students it is important that all major fields are represented in the department, see also the above cited statement by the RAE 2009.

2) Hirings should be coordinated to achieve a rational faculty age distribution by 2020 and beyond. Hence the SAB supports that each year the department aims to grow annually by one faculty.

3) Internationality of the faculty: For a top university it is extremely important that hirings can be done on the international level. An option for Aalto University as a whole could be to aim that in the long run only a small and necessray portion of lectures be given in Finnish.

4) Currently the name of the department still reflects the history of formally unifying two laboratories. It is also claimed that the name is important for visibility for students. The SAB suggests that there are other ways to make each group of the department attractive to students. It is hoped that with the new Master's program in applied and engineering mathematics, jointly with KTH, Chalmers, DTU and NTU, will attract more international students in the long run also for doing a Ph.D. at Aalto.

Department of Media Technology (limited commentary only due to absence of an SAB member from the February 2012 visit)

Being formed in 2008, Department of Media Technology (MT) is a young department in the vibrant area of media-related topics. It is currently focusing on web technologies and services (including the semantic web), interactive graphics and audio, and applied perception. MT covers a multidisciplinary field with very appealing modern settings like game design. In the field, applications (systems, demos) tend to capture more attention than scientific papers. Finding the balance here is not an easy task, but the department has made substantial progress in this respect and even obtained several awards (like the UNESCO award for its SmartMuseum system).

Following the recommendations of the RAE in 2009, the department has taken active steps to increase its level of scientific excellence (e.g. through top quality papers and theses) and to become more visible internationally. The SAB strongly encourages the further initiatives that are planned along this line, like the anticipated application for a CoE. As the field is multidisciplinary there may a need to create a large group or network of experts from different fields like psychology, sociology and, not to forget, computer science. Potentially the field could also be very attractive to female students and researchers e.g. following the trend towards human interaction with media.

The challenge for the department is to define the vision and the mission for its future development in an academic environment. Where will the department be in ten years? What are the future-oriented long-term goals? Is the future technological only? Should the cooperation with the School of Arts, Design and Architecture be expanded? The area of MT has enormous potential, e.g. in the development of social media and the future web.

Given the background of the staff and the students, the SAB wonders why MT is not part of `computer science'. There are many common concerns, granted that the emphasis of the field is more directly application-oriented than generically oriented areas of computer science. The cross connections should be explored and exploited for mutual benefit. (See also section below entitled "*On the role of computing, computational sciences, computer sciences etc across the School of Science").*

Department of Applied Physics

The Department of Applied Physics received very strong reviews in the RAE of 2009. In terms of its internal research, the department is exceptionally strong in specific areas such as computational condensed-matter physics and nanoscale quantum electronic devices technology, for example. Insofar as quality of research goes, the department appears to match well with the strategic ambitions of the SCI. Since the formation of Aalto University, the department's hiring has be robust and vigorous and seems to be on an exemplary track including further internationalization of its faculty, staff, and students.

In this brief commentary the SAB will focus more on the need of the development of a well enunciated strategic plan for the department over the next 5-10 years, something which was not well presented during the SAB visit. While the "state-of-the-department" lies indeed on a very solid foundation of scientific quality, the department should challenge itself (and be challenged by the SCI) in planning a SCI- and Aalto-compatible roadmap for its next level of elevation, given especially the opportunities with the anticipated substantial number of new hires in the next decade. The RAE2009 report noted that "*The department also appears to be very open-minded and interested in considering multi-disciplinary opportunities, for instance in collaboration with chemistry, chemical*

engineering, electrical engineering, mathematics, and computer science". Yet evidence for this trend to be placed into practice in the SCI and larger Aalto spirit seemed rather vague to the SAB. The point deserves emphasis in that new faculty should be arriving to a culture where there is real recognition of the value of crossing both departmental and inter-School lines to enriching their research. Such a culture can also help the development of energetic, emerging younger leadership for the department and the SCI.

In terms of key potential focus areas for obvious synergy within the SCI, the SAB noted the rich overlap in the quantum transport and nanodevice technology areas with the Low temperature Laboratory (OVLL). In the strategic context for the SCI and the Department of Applied Physics, the SAB is encouraging the department leadership to pursue and formulate concrete ideas for possible integration of research and faculty to capitalize fully on this synergistic focus area of excellence.

Another matter, now running across the SCI and the School of Engineering relates to the following from the RAE 2009 report: *"The Panel wishes to raise a structural question concerning the Applied Physics Department and the Department of Micro- and Nanosciences as follows. It appears that there are elements in the latter, within the Micronova lab, which could greatly benefit from formal affiliation with Applied Physics. The boundary between the two departments is rather diffuse, and while perhaps due to historical and other reasons, appears somewhat artificial and not entirely logical in purely scientific terms. Perhaps the establishment of the Aalto University will enable a re-examination of departmental strategy in this specific context.*" The SAB notes that while this point was not raised by the department head during our February visit, it can and should remain proactive and be yet another possible element in the continued development of a real strategic 5-10 year plan by the department leadership.

In sum, the SAB was left with an impression that a strategic plan by the department was not yet developed in terms of its vision within SCI and Aalto. The above comments have been made in the spirit of urging proactive measures to be taken soon.

Department of Computer Science and Engineering

The Department of Computer Science and Engineering (CSE) is a traditional department, with a focus currently on the following classical areas within ICT: software systems and technology, data communications software, and software engineering and business. The department's research is typically driven by applications in industry, aimed at developing generic software and systems technologies and emphasis on industrial impact. The department is selective in applying for external funding, to keep a high level of research quality. It carries a heavy load of basic software and systems education for all other degree programs at Aalto.

In the view of the SAB, the department is currently at a unique crossroads. On the one hand, of its current professors, only four will continue after 2016 (due to retirements and expiring fixed-term contracts). At the same time the `software field' is changing and a more tangible vision than the current one (`creating value using software') may be needed. Altogether it gives a unique opportunity for the department to reinvent itself, develop a new strategy, and support it by the new expected hirings of new (and younger) professors in the near future.

The SAB recognizes that the department faces a non-trivial problem of refocusing and re-targeting. The current ideas to re-shape along the lines of `software systems and technology' and `software engineering and business' are promising but seem to leave the basic question open what vision (of the whole ICT domain for that matter) would drive the further choices to be made. As many options represent vast areas (multi-core computing, web-based systems, distributed development, social computing, etc), further guiding principles are needed without narrowing the department or the opportunities for excellent staff too much. How will the department want to `sell' its area in the future, to new faculty and to students (incl female students)?

CSE clearly covers an important area of `computer science'. Software technology and its embedding in industry and business will continue to be highly important, and it is thus of great importance to attract the interest of young people as potential students for it aggressively. The interest may be higher for the challenges of design (like game design) and entrepreneurship than for the challenge of generic technology per se.

(See also section below entitled *"On the role of computing, computational sciences, computer sciences etc across the School of Science").*

Department of Information and Computer Science

The Department of Information and Computer Science (ICS) is a leading department devoted to fundamental computer science, supported by novel applications. The department currently focuses on the following four areas: algorithmic techniques for global computing, data-intensive modelling and inference, models and algorithms in computational science, and fundamental models and methods in computer science. These areas are broad but quite characteristic for a high quality department. The department is e.g. part of three CoE's and is `publication-intensive'. (The SAB refrained from a discussion of the relative merits of conference vs journal publications in computer science, recognizing that this is the standing culture of the field.)

In the view of the SAB, it is confusing to have separate departments of CSE (Computer Science and Engineering) and ICS (Information and Computer Science) in one school, as both cover parts of the same science called computer science and are normally found in one Department together. (See later remarks.) This aspect aside, it is clear that even fundamental research in computer science has highly multidisciplinary trends (e.g. in computational biology and in economic modelling) and collaborations of ICS with other areas are likely to have to extend well beyond the boundaries of traditional computer science.

The SAB does not foresee that the current focus areas of ICS will need to be revised shortly, although this may be influenced by new hirings or new desired developments. The department will have a personnel issue in the coming years (2014-2016) due to some retirements and long-term absences. It will be hard to replace senior tenured professors of high quality, and mostly candidates at the Assistant and Associate levels are expected to be hired instead, in the new tenure track system.

Whereas student interest is good, it may become increasingly difficult to recruit good to excellent students at the master level. International competition is rising. The focus areas of the department should be used in advertising the department to potential students, supported by suitable demos of

(large) projects. Students like to work in groups rather than individually `only' and this can typically be achieved in project settings.

(See also section below entitled *"On the role of computing, computational sciences, computer sciences etc across the School of Science").*

Department of Industrial Engineering and Management

A research assessment exercise and a teaching & education evaluation was conducted in 2009 respectively 2010-2011. We therefore mainly review what has been done in view of the recommendations arising from these earlier assessments.

The Department of Industrial Engineering & Management (DIEM) was created out of a merger of the former IEM department at TKK and the SimLab & BIT Research Centre. It currently is one of the larger departments of Aalto's School of Science (SCI).

However, why DIEM is embedded in Aalto's School of Science is unclear in the context of a strategic vision for DIEM and Aalto, respectively. During the SAB visit, the head of the department gave a historical explanation to justify for this situation. However, a convincing rationale should be developed for placing IEM in the science core of Aalto University, rather than in the School of Engineering (cf. "Industrial Engineering") or possibly the School of Economics (cf. "Economics & Management"). DIEM's position in the School of Science is particularly questionable because its prevailing research approach (i.e. problem-initiated research, with multiple research methods and empirical data collected from companies) is very different from the research methodology used in most other departments of SCI.

DIEM has set the very ambitious target for itself of a unified, 'world-class' department focusing on the creation and transformation of technology-based business. This ambitious target and strategy have already started paying off. The publication record has been improving in terms of the quality/quantity of publications and the Crown index. Several new tenure-track (assistant) professors have been hired. The department also appears to be thriving in terms of its ability to attract a large number of (high-quality) students. However, the SAB believes more needs to be done to actually become a 'world-class' department.

1) DIEM's research strategy was assessed as unclear in 2009. The transition to the new DIEM at Aalto SCI (including the merger with SimLab and BIT Research Centre) appears to have delayed the effort to develop a strong coherent research profile. (Note that Aalto University's website still lists SimLab and BIT Research Centre as separate entities.) The department currently focuses on "Creating and transforming technology-based business", driven by three perspectives (strategic management, operations management, and people/leadership). As such, there is a high potential for breakthrough research that combines the complementary strengths of the three perspectives, but this potential is not yet visible in terms of a substantial volume of shared PhD projects and/or shared research output. The SAB thus recommends to facilitate the development of a collaborative research culture that brings the three perspectives together in shared projects and programs; for example, by way of (co)funding PhD projects at the interface of at least two groups within DIEM.

2) DIEM's international collaboration appears to concentrate on Stanford University (via Scancor and STVP). Although this is a good first step towards international exposure and "learning from the best", it is not sufficient if DIEM truly seeks to become a world-class department in (technology-based) new business creation. It is also important that DIEM, in the longer run, does not depend too much on a single institutional alliance. The SAB therefore recommends that DIEM broadens its network of institutional alliances towards several other leading departments or schools in the area of new business creation and growth.

3) Broadening its network of alliances will also be instrumental in strengthening the vision and strategy regarding both education and research. In this respect, the SAB observed that the Teaching & Education Evaluation committee (in 2011) advised to conduct an in-depth international benchmarking exercise, but that this advice has not yet been followed up.

4) DIEM's current population of 17 full professors is reasonably balanced in terms of age distribution and experience, with 5 to 6 professors retiring in the next five years. The latter provides a substantial opportunity to renew the department at the senior level, in line with DIEM's long-term research strategy. The SAB recommends the department to recruit (tenure-trackers that have the opportunity to become) full professors that already have a track record in multi-disciplinary research cutting across at least two of DIEM's three core perspectives.

5) Finally, the relationship between SCI and the School of Economics seems to be somewhat disconnected, if not troubled. Therefore, the SAB advises Aalto's leadership to create strong incentives for the School of Economics and SCI to team up in collaborative research projects and educational programs (e.g. around entrepreneurship), preferably also by means of shared appointments of new professors.

Low Temperature Laboratory (OVLL)

The O.V.Lounasmaa Laboratory is an institution of its own in Finland, with truly an international reputation and long list of notable achievements. Its past and current faculty have reached in several instances scientific levels of research where the term world-class is accurate and not only an aspiration. Accordingly, in the RAE2009 evaluation the scientific merits and value of the OVLL were highly rated. That report also raised several questions about the future role of the faculty of this henceforth singularly autonomous unit in the new Aalto construct.

It is encouraging to see that some of the RAE recommendations have started their way to implementation such as the faculty of the OVLL participation in teaching within the SCI. Yet, much remains to be done in formulating the role and plan for the OVLL in the new enviroment while considering both its assets and potential in the decade(s) to come. This includes the assessment of the field of low temperature physics as to its future vibrancy. The SAB recognizes that there has been an unplanned and unfortunate leadership challenge that abruptly developed in 2011. Hence perhaps unsurpisingly, we did not hear much about the development of a strategic plan for the OVLL during our visit.

As already noted above in discussing the BECS as a department, there is much to gain for building and pursuing further synergy in the areas of brain imaging and neurotechnology (and much to lose

while stabnding still). It is welcome to see the Aalto Brain Center (ABC) project on a map, yet its first steps appear to be rather tentative and not (yet) sufficiently leadership driven. Likewise, as noted above in discussing the department of Applied Physics, the overlap in the field of quantum transport nanoscale devices and their rich physics is more than ripe for synergy with OVLL. Some collaborations are clearly in evidence but to the SAB it is unclear how the two units propose to combined their visions for enriching opportunities in this lucrative field.

Obvious major questions at the SCI and Aalto University leadership level apply to the OVLL and its vision and place within Aalto, 10 years from now and beyond. The SAB will not endeavor to offer suugestions at this time but will simply point to the questions raised in our minds during the February visit: does OVLL have sufficient momentum to keep itself as is; will OVLL turn into a normal academic department; might OVLL be strategically integrated with other departments of SCI etc?

Helsinki Institute for Information Technology

HIIT is a joint research institute of Aalto and the University of Helsinki. The institute is devoted to top level research in IT and is largely externally funded, with a strong collaboration between research and industry. The institute is organized along the lines of four research programs: two in computational modelling and analysis (algorithmic data analysis, computational inference) and two in the ubiquitous ICT in the modern networked world area (scalable networking, network society).

The SAB concurs with the view expressed in the RAE 2009 that the cooperation in HIIT is a good concept for attracting external funding and as such a win-win-partnership for Aalto and UH. This aspect aside, the research in HIIT clearly adds to the impressive `palette' of computer science research of Aalto in particular. HIIT has reportedly implemented most recommendations of the RAE in 2009 now. For example, a long-term strategic research plan was written. The SAB could not explore this on its current mission but will do so with great interest on a future occasion.

HIIT contributes to four national Centers of Excellence (CoE's), and coordinates two doctoral program. It is a hub for almost 200 researchers, many of whom have double appointments and also work at departments. (The SAB refrained from a discussion on how to measure the quality of basic research, recognizing that this involves a mix of many criteria from good applications to results that ends up in a text book.)

On the role of computing, computational sciences, computer sciences etc across the School of Science:

General Observations:

As noted in the Executive Summary, the word Computer or Computing appears in no less that three department titles (four or five, if one implicitly also counts in the HIIT and elements of MT). There may be historically understandable reasons for this nomenclature but, both at the superficial level (i.e. presenting a facade to the outside world) and at the more fundamental level of harnessing the intellectual, research, and educational power of these three departments, the present organization appears to be far from obviously optimal.

At the superficial level, the SAB appreciates the argument that ”computing” and/or ”computation” is pervasive in today’s practice of science. But this fact is implicitly and globally well-recognized as

being a key element in the practise of 21st century science. It need not and should not translate to explicit and redundant use in departments' naming that might lead to perceptions of less than coherent organization and distribution of "computing" within the SCI.

Accordingly, the SAB believes that the multiple computer engineering/science and computational elements within the SCI should consider, and implement, new strategic alliances amongst each other. This should lead to a more rational design of their departmental structure in the future, including some definitive consolidation where integration of the "computational" parts is larger than their simple sum.

***Example: Broad Recommendations for Media Technology, Computer Science, and HIIT*:**

The units that include computer science seem to be at different stages in the transition between professorial groups and a fully fledged department of computer science. For a strong discipline of computer science and the recognition of Aalto's strength in this discipline, it should be considered whether four independent units (MT, CSE, ICS and HIIT) are optimal. For example, a common strategy will be more productive than a dispersed one. A joint platform to represent Aalto's computer science will be more influential than a divided one. Management may be more effective when done jointly.

The SAB suggests to explore the options and advantages of greater strategic cooperation of the units, whether it be a platform or even a full-fledged Aalto School (or Department) of Computing. There are several aspects to this suggestion which motivate the SAB: the likely benefit for MT to represent a modern part of `computer science', the benefit of having CSE and ICS in one department, and the recognition of HIIT in the cluster (even though it would maintain its independence as a unit).

The SAB is convinced that there is an opportunity for Aalto to strengthen its position as a world-leading centre in computer science, without a need for drastic measures. Even in a joint structure, research groups still represent their own areas. One possibility might be to make a senior appointment to a new position as head of a joint Computer Science department with the mandate to provide the vision to effect a gradual integration of the current departments, building on the strengths of those that are performing well and helping to refocus those that are still in a period of transition.

However, towards the future, related domains will emerge and greater synergy will occur if people work on it together, especially if they work from different angles. There is a unique opportunity now, given the future scenario for MT and the strategy renewal process for CSE.

Additional Remarks:

The SAB was also asked to look into other specific questions (see below) below. Given the full agenda for this first SAB visit, we feel that in order to deal with these, more information (and digestion by SAB) is needed. The SAB looks forward to attending these items as well as deepening our undertanding of those issues which this report has already targeted. To wit:

- The school is responsible for a large amount of service teaching for all other Aalto schools in the area of Technology. The large classes in Maths, Physics, Computer Science and Industrial

management having 200-900 students tide up lots of resources. How to organize resources to maintain a good balance between research and teaching?

- We have many part-time PhD-students (many in relatively demanding jobs) whose progress tend to be sluggish, do you have any advice how to better organize their supervision and support their progress?
- We have many part-time undergraduates (most of them working for getting working experience and/or for getting money for living) and due to that the duration of their studies is quite long. How to motivate them to full-time studies?
- Our gender-balance is not very good. How to increase the amount of female students/faculty ?

Finally, we wish to underscore that this was indeed the first visit by the SAB to the School of Science. To cite from page 1 of this report: "*This was the first meeting of the SAB. For several members this was also a first visit to Aalto Univ. Thus the purpose of the meeting served to get acquainted with the School of Science, its current state of development, and to form a very general first impression of the departments and laboratories of the school. Most attention was given to the current status of the School at the Departmental level. The departments and laboratories were represented by the heads, who gave (very) short overviews of their current focus areas, achievements, challenges and current 'strategic' actions (without site visits). The SAB report is NOT meant to be all-encompassing but rather focus on few specific items on this first SAB visit. A number of other important items are note discussed in this report but are deferred to subsequent SAB meetings*"

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Advisory board members' short resumes: (those participating in this report)

Rolf Jeltsch is a Professor of Mathematics at ETH in Zurich. He holds a Ph.D. in mathematics from the ETH. Dr. Jeltsch is a fellow of the National Mathematical Centre, Abuja, Nigeria, and a foreign member of the Finnish Academy of Science and Letters. He received an honorary degree from the North University of Baia Mare, Romania, in 2000, of the Helsinki University of Technology in 2008 and of the Vietnamese Academy of Science and Technology in 2010. From 1997 - 1999 he was president of the Leonhard Euler Center which is the Swiss Pilot Center of the organization European Community on Flow Turbulance and Combustion (ERCOFTAC). He was president of the European Mathematical Society 1999-2002 and the Swiss Mathematical Society 2002-2003. He was President of the Gesellschaft fur Angewandte Mathematik und Mechanik, GAMM, 2005-2007 and Vice-President 2008-2010. He chaired the Scientific Council of the Banach Center from 2002 to 2005 and is advisor to several research institutes in Europe. He was President of the organization ICIAM, International Council on Industrial and Applied Mathematics, October 2007 - September 2011. He was the Congress Director of the congress ICIAM 2007 held in Zurich 2007. He is the Chair of the Panel PE1, Mathematics for the European Research Council, ERC Advanced Grant for the years 2009, 2011, 2013. Dr. Jeltsch's major research interests are in numerical analysis. In the 1970s, his work centered on ordinary differential equations. Since the 1980s, Dr. Jeltsch has focused on hyperbolic partial differential equations, especially systems of conservation laws with applications. In addition, he conducts large-scale computing in scientific and engineering applications.

Jan van Leeuwen is a Professor (em.) of Computer Science at Utrecht University, the Netherlands. His scientific interests in computer science ranges from algorithmic modeling and complexity theory to formal methods, and to applications of algorithmic design and optimization in general. Jan van

Leeuwen advised extensively on fundamental developments in the computer sciences and ICT, in advisory councils of leading scientific institutions and in industry. During 1994-2003 he was a series editor of the series Lecture Notes in Computer Science of Springer-Verlag. He was dean of Mathematics and Computer Science and later vice-dean for Natural Sciences of the Faculty of Science at Utrecht University. Jan van Leeuwen is a member of the Royal Netherlands Society of Sciences and Humanities and of the Academia Europeae. In 2008 he received an honorary doctorate from the RWTH Aachen University. In 2009 he received the first Distinguished Lorentz Fellowship Prize. For more information, see: http://www.cs.uu.nl/people/jan/

John Shawe-Taylor is Professor of Computational Statistics and Machine Learning at University College London in the UK. He is also currently Head of the Department of Computer Science at UCL. He has published over 200 research papers in areas ranging from graph theory through cryptography to statistical learning theory and machine learning. He has pioneered the development of the well-founded approaches to Machine Learning inspired by statistical learning theory including Support Vector Machine, Boosting and Kernel Principal Components Analysis and has shown the viability of applying these techniques in a number of application domains. He is co-author of an Introduction to Support Vector Machines, the first comprehensive account of this new generation of machine learning algorithms. A second book on Kernel Methods for Pattern Analysis was published in 2004.He has coordinated a series of European Research Networks including NeuroCOLT, NeuroCOLTII, PASCAL and PASCAL2. For further information see http://www.cs.ucl.ac.uk/staff/j.shawe-taylor/.

Georges Romme is professor of Entrepreneurship & Innovation at Eindhoven University of Technology (TU/e) and is currently also serving as dean of the Industrial Engineering & Innovation Sciences department at TU/e. He holds an MSc in economics from Tilburg University and a doctoral degree in business administration from Maastricht University. Georges was an International Visiting Fellow of the Advanced Institute of Management Research (AIM) in the UK. In addition, he received several educational and best teaching awards from the European Foundation of Management Development (EFMD) and Maastricht University. His previous work was mainly on new organizational forms, organizational learning, and (design) research methods. More recently, technology entrepreneurship and the design of incubation systems have become key research topics. In this respect, Georges has pioneered the notion of organization research as a design science. This fascination with 'science for design' is evident from his work on designing circular organizations, educational systems that produce deep learning, and incubation environments for technology startups. For more info:
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Arto Nurmikko is a L. Herbert Ballou University Professor of Engineering and Physics at Brown. He recived his degrees from University of California, Berkeley, and did postdoctoral work at the Hebrew University (Jerusalem) and MIT. He has been the co-director of the Center for Biomedical Engineering at Brown. Professor Nurmikko conducts research in neuroengineering, photonics, microelectronics, nanosciences, and the translation of device research to new technologies in physical and life science applications. His current interests are focused on device science especially for implantable neural interfaces. Other components of his work involve development of ultracompact semiconductor light emitters and ultrafast optical switching of magnetism. Nurmikko has published in several fields (over 350 journal articles), led many multi-institutional research teams in the U.S., advised federal funding agencies, and lectured worldwide. Professor Nurmikko is a Fellow of the American Physical Society, of the Institute of Electrical and Electronics Engineers, and of the Optical Society of America. He has been the recipient of a Guggenheim Fellowship, and elected to the American Academy of Arts and Sciences and to the Finnish Academy of Science and Letters.