The Research Council of Norway

Simula Research Laboratory

An evaluation

Evaluation
Division for Science

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The report can be ordered at:
www.forskningsradet.no/publikasjoner

or green number telefax: +47 800 83 001

Design cover: Design et cetera AS
Photo/illustration: PhotoDisc
Printing: The Research Council of Norway
Number of copies: 300

Oslo, May 2010

ISBN 978-82-12-02796-1 (printed version)
ISBN 978-82-12-02797-8 (pdf)

Preface

This report summarizes the findings of the evaluation of Simula Research Laboratory A/S done during 2009. The evaluation was initiated by the Research Council of Norway on behalf of the Ministry of Education and Research. The purpose of the evaluation is to give an impartial and complete report on the activity at Simula.

The evaluation was split into two sub-evaluations, each with its own evaluation committee.

1. **The Scientific Evaluation**: An evaluation of the quality of the research conducted in the center
2. **The Concept Evaluation**: An evaluation of Simula as a new concept in the Norwegian R&D system

The sub-evaluations were spaced in time such that the report from the Scientific Evaluation was given as an input to the Concept Evaluation Committee.

In order to define the boundary between the two evaluations, the mandate for the Scientific Evaluation was focused towards scientific issues and the scientific leadership at Simula. These issues are general in the sense that they are approximately the same for all research departments or research groups. In general, they are independent of how the department or group is organized, and is usually independent of whether or not the department or group is a part of a larger research organization. Issues of relevance that did not belong in this setting were addressed in the Concept Evaluation.

The Research Council of Norway, June 2010

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Part I

Scientific Evaluation

To the Research Council of Norway

The members of the 2009 Evaluation Committee reviewing the Simula Research Laboratory are pleased to submit the enclosed report on this date, July 8, 2009. The views expressed in this report are the unanimous opinion of the members of the Evaluation Committee. The members of the committee are in full accord with regard to the assessment, recommendations, and conclusions stated in the report.

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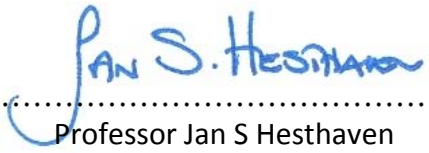
Professor Torsten Braun
University of Bern, Switzerland



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1. Executive summary and recommendations

The Evaluation Committee is impressed by the consistency and overall high quality of the activities of the Simula Research Laboratory, and the growth and increasing impact it has seen since the last evaluation. The organization has matured to become a vibrant research culture and continues to operate as a highly effective research unit with a well-established and increasing international recognition. We commend the quality of the self-evaluation document as a thorough and accurate assessment of the current state of the laboratory with a nice balance of awareness of current strengths and weaknesses.

The Committee finds substantial improvements in all the three research departments, and a growing diversity of activities while maintaining research focus. The committee also finds it encouraging that the organization has worked hard, and with focus, to develop more educational and business oriented activities as would be expected by a maturing research organization.

The Simula Research Laboratory offers a unique environment that emphasizes and promotes basic research while still covering the broader landscape from postgraduate teaching to commercialization. The organizational and funding framework allows basic research to take center stage, without substantial constraints from the pursuit of external funding typically found in industrial research institutes, or from the heavier teaching commitments found in University environments. This emphasis gives the laboratory the opportunity to be highly productive in its chosen focus areas. With finite resources available, the organization can only cover a limited number of such areas, and the strategic choice of these areas is of vital importance.

Prior to entering into a more detailed discussion, it may be helpful to highlight a few observations, all of which are later discussed in more detail. These are areas of a more general strategic nature and will shape much of the discussion and subsequent recommendations.

- At the departmental level, the original leadership model, based on research active leaders, is being stretched to its limits. Furthermore, an increasing fragmentation of some departmental research activities is beginning to dilute the original vision of long-term directed research, focusing on large-scale problems.

- The focus of the research activities at the Simula Research Laboratory continues to be centred on the three original research areas, all selected at the establishment of the Laboratory. A more dynamic model appears to be needed to secure the long-term health of the research enterprise. Such a model must include an ongoing evaluation of research areas and periodic national competitions to ensure the chosen research areas remain the most appropriate activity areas, maximizing the benefit to the Norwegian society.

- The establishment of SSRI introduces a new and educational entity into Norwegian science and it is clear that SSRI has to potential to significantly impact Norwegian science education and its broader influence. SSRI could well grow to become a national resource for science education and take on a role as a coordinating center across several universities engaged in research activities shared with the Simula Research Laboratory. Such opportunities should be explored and strengthen.

The uniqueness of the research environment is in many ways also the most fragile element as Simula transitions from an emerging research environment to a mature research organization. The Evaluation Committee ***recommend***s that Simula leadership, in close relationship with central stakeholders, strive to find a way of maintaining and revitalizing the organization in the spirit of its original vision. Without this, the Evaluation Committee sees a danger of loosing this uniqueness with the unfortunate outcome of Simula becoming a more traditional research environment.

The Evaluation Committee applauds the development of a longer-term strategic plan (Strategy 2007-2015), and sees clear evidence of its implementation. However, the Evaluation Committee does feel that the Simula Research Laboratory's strategy is somewhat static. While it might be appropriate to continue with the current directions at present, we

would have liked to see a more critical discussion of the likely evolution of the targeted areas on a longer time-scale.

The Evaluation Committee ***recommends*** that the Simula Research Laboratory revisits its strategy development with the aim of developing a more dynamic tool and process for its implementation. It is important that this strategic plan takes a long-term view of the laboratory as a whole and consider renewal of the research fields without being bound unduly by the current departmental structure in basic research, or the choice of focus areas made during the formation of the Simula Research Laboratory.

The Simula Research Laboratory is based on a strong relationship with the University of Oslo that has been formalized and further strengthened during this evaluation period. This is clearly to the benefit of both institutions. However, for the long-term health and uniqueness of the Simula Research Laboratory, it is important to broaden its base and to develop similar relationships with other Norwegian universities. Such partnerships will provide new opportunities for the development of research and educational activities, as well as to offer an expanded base for recruitment. The Evaluation Committee ***recommends*** that at least one additional formalized partnership with another Norwegian university be developed and implemented.

The Evaluation Committee strongly supports the creation and continued implementation of SSRI as a core educational component of the Simula Research Laboratory. The formalized structure of SSRI has enabled the development of innovative new courses, improved mentoring, advising, and community building among the students. Such initiatives are essential for an internationally oriented research and educational organization. The Evaluation Committee ***recommends*** that the development and expansion of SSRI continue, and that nationally taught courses based on Simula's specific expertise be developed. Such initiatives could be implemented as intensive courses or as regular distant learning classes. This provides a unique and exciting opportunity to increase visibility and interaction with the Norwegian research community and develop innovative new means of science education.

The Simula Research Laboratory has created a healthy PhD program in which 35 students are currently participating. We applaud steps taken in order to ensure diversity in gender and educational background. The number of PhD students remains below the target of 45, and the Evaluation Committee ***recommends*** the implementation of this target. However, we caution that a continued expansion beyond this target may weaken the original intention of the Simula Research Laboratory as a long-term research focused activity.

During this evaluation period, the Simula Research Laboratory has strengthened its international collaboration, and has taken steps towards the formation of genuine and formalized international partnerships. However, the Evaluation Committee feels that these collaborations have not yet reached full maturity and extent. One potential implication of this is seen in the absence of participation in EU funded projects. The Evaluation Committee ***recommends*** that these activities be continued and strengthened with the aim of increasing international visibility, and with the explicit goal of participation in successful European project consortia funded through the EU Framework Program.

This period has provided strong evidence that the Simula Research Laboratory directly benefits Norwegian industry by producing a stream of highly qualified PhDs being placed in industry, and by engaging industrial collaborations with key Norwegian companies. It is encouraging that these collaborations are found throughout the Simula Research Laboratory and the Evaluation Committee supports that such collaborations continue and expand.

The Simula Research Laboratory leadership expressed a concern about the inability to use academic titles in the recruitment and the retainment of research leaders. The Evaluation Committee ***recommends*** exploring more thoroughly the existing opportunities in Norwegian universities such as Professor II appointments. A longer-term possibility could be the establishment of a Research Professor title.

The Evaluation Committee ***recommends*** strongly and without reservations that the Simula Research Laboratory be funded for the next 5 years.

The Evaluation Committee has noted the concerns expressed in the self-evaluation document regarding the lack of a long-term funding commitment to the Simula Research Laboratory. While the Evaluation Committee appreciates that budgetary concerns and long-term funding models may be outside of its mandate, it nevertheless wishes to express its views on these concerns, as it believes that a clarification of these particular issues is closely tied to the long-term scientific health of the Simula Research Laboratory. In doing so, the Evaluation Committee will largely support the basic recommendations made in the last evaluation report.

The Evaluation Committee fully appreciates that an uncertain or lacking long-term commitment may adversely impact staff morale, influence stability and retainment, and lead to substantial distractions from the research goals. It agrees that this has the potential to be a real threat to the long-term health of the Simula Research Laboratory. It would indeed have a severe impact on the organization if key personnel were to be lost due to this uncertainty. To ensure long-term continuity and organizational health, the Evaluation Committee ***recommends*** that the Simula Research Laboratory be placed on a rolling 5+5 year contractual agreement. In line with the recommendation of a more dynamic strategic plan, an evaluation should be performed at the midpoint of these 10 years, examining performance and plans for an additional ten years. If the evaluation is sufficiently positive, the contract should be extended so that the laboratory never has less than a five-year planning horizon.

The Simula Research Laboratory leadership has also expressed concerns about the decreasing total shares of the budget being funded by the core funding and the impact this has on the core research activities. The Evaluation Committee shares this concern, as it collides with the original vision of the Simula Research Laboratory as a research organization with limited dependencies on externally funded, short-term activities. The committee ***recommends*** that steps being taken in order to reassure core funding commensurate with the level and original vision of the Simula Research Laboratory.

2. Simula Research Laboratory evaluation

2.1 Research assessment

2.1.1 Level of research

The Simula Research Laboratory has continued to consistently achieve a high level of quality research output. The "Scientific Computing" department has maintained its high level of visibility, increased its activity and impact, and developed extensive collaborations with outside partners, including major industrial partners. The department is excellent in every aspect. The "Software Engineering" department has improved considerably and has complemented past activities by initiating and developing a new research area. This department can likewise be judged as excellent. The "Networks and Distributed Systems" department has improved its overall level. While certain projects are excellent, others have not reached their full potential. The department as a whole is very good.

Over all, the upward trend in the quality of research activities is very encouraging and bodes well for the future. The publication rates in all departments have increased significantly since 2004. This is reflected in the maturity level of the research activities and in the overall significant growth of the Simula Research Laboratory since the last evaluation.

2.1.2 Importance of research fields

The three areas covered by the departments remain important and continue to develop as research fields internationally. The departments worked hard, and with focus, to find ways to position themselves internationally within their research area in order to maximize their impact. The departments remain focused in their areas of expertise, although there are some early signs of fragmentation resulting from special staffing or funding opportunities. The strong growth of the "Scientific Computing" department is commensurate with the general international trend.

While the research areas remain important and active, a future challenge will be to evaluate whether these three departments and research focus remain the most appropriate research areas in which to direct the significant resources of the Simula Research Laboratory.

2.1.3 National and international scientific collaboration

The Simula Research Laboratory has strong national and international ties with collaborators from leading universities and research institutes. It has high visibility partly due to several internationally recognized senior research leaders, and there is clear evidence that the Simula Research Laboratory is operating and collaborating as an equal partner with many of the best institutions in the field. The strong relationship with the University of Oslo has continued to develop during this evaluation period, and it has been formalized to the benefit of both research and education.

Relationships with several other Norwegian and international universities exist; although of a less intensive nature. It remains a challenge and an opportunity to develop closer relationships with additional partners in order to strengthen the research and educational network of the Simula Research Laboratory.

2.1.4 Participation in European Framework Programmes

In agreement with the Simula Research Laboratory and its leadership, the Evaluation Committee is disappointed with the very low level of participation and success rate in the European Framework Program. Recent activities show the awareness of this shortcoming, and the recent contracting of a consulting company to support proposal development is a positive step. Stronger relations and partnerships with European institutions would further facilitate the formation of a successful consortium. This issue must be a priority in the future development of the Simula Research Laboratory.

2.1.5 Contribution to education at MSc and PhD levels

Compared to the situation in 2004, Simula has made impressive improvements in the education of Master and PhD students. This is largely due to the creation of the SSRI, but also related to the significant increase in the external funding of PhD students.

The formalized structure of SSRI has enabled the development of innovative new courses, improved mentoring and advising, and community building among the students. Such initiatives are essential for an internationally oriented research and educational organization. The committee strongly supports the ongoing development and future

expansion of nationally taught courses based on the Simula Research Laboratory's specific expertise. Such activities can significantly increase the impact of the Simula Research Laboratory within the national universities and industrial partners. The initiatives can take several forms, including intensive summer/winter school, distance learning courses, and the formation of dual-advisor models requiring equal participation of researchers from the Simula Research Laboratory and University/industry partners in PhD education efforts.

The committee applauds that out of the current 35 PhD students there are 9 women and 15 students with a foreign background. The number of PhD students remains below the goal of 45 PhD students set by the Simula Research Laboratory. In order to reach this number, additional funding is required.

The Simula Research Laboratory leadership expresses an interest in attracting a higher number of Master students, but finds it difficult to reach this target. The Evaluation Committee feels that SSRI has not sufficiently reached out to Universities outside of Oslo. In order to successfully overcome the challenge of temporarily relocating students, SSRI may need to offer incentives and increase attractiveness and visibility at national Universities. This may require additional resources.

While the Evaluation Committee supports a moderate growth in the number of Master and PhD students, we caution that a continued expansion may weaken the original vision of Simula as a long-term research driven activity.

2.1.6 Attractiveness

The range of visitors to the Simula Research Laboratory provides evidence that the academic environment is attractive. We believe that the amount of joint work reported makes it clear that the Simula Research Laboratory is regarded internationally as a productive and attractive research partner. The attractiveness of the Simula Research Laboratory environment is clearly demonstrated by the recruitment of four international mid-career or senior researchers and project leaders.

The Evaluation Committee suggests that a more formalized and publicly announced visitor program should be initiated to further increase visibility and the number of international visitors. Financial support for such activities may be secured through European internationalization and mobility programs.

2.1.7 Relevance to Norwegian industry and society

This evaluation period has provided strong evidence that the activities at the Simula Research Laboratory directly benefits Norwegian industry in a number of ways. By producing a stream of high quality PhDs subsequently placed in industry, it helps to lift the general quality and skill level of the workforce. Engaging industrial collaborations helps to formulate and solve new problems, and to introduce new ideas into the industry increases competitiveness.

The most visible example of this is the close and extensive collaboration with StatoilHydro. However, the development of other recent collaborations is encouraging and highlights that this is not an exception. The examples of collaboration with Telenor and DNV emphasize that such industrial collaborations are involving all departments of the Simula Research Laboratory.

2.1.8 Innovation and business establishment

The Evaluation Committee is pleased to see that steps have been taken to support innovation and business development. Given the size of the Simula Research Laboratory, the achieved output in terms of spin-offs, as well as of their development, is reasonable. A longer-term strategic plan for business establishment and exit strategies has not been developed and would require substantial new financial and managerial resources. It is questionable whether the Simula Research Laboratory should develop this to a larger extent given the finite resources and the strategic research driven goals of the Simula Research Laboratory.

2.1.9 Research plan and strategy

The previous Evaluation Committee expressed the following: “The current strategy concentrates on consolidation and completion of the original vision of the three

departments. This is quite understandable, since the Simula Research Laboratory is still completing its initial steps, and so the direct consequences of them loom large in the management's thoughts. However, we believe that the laboratory needs to think in terms of a changing portfolio of projects and interests, and it is not too soon to start addressing the intellectual renewal process."

We share this view, and in light of increasing maturity of Simula, we believe that this is becoming an issue of growing concern. In a long-term scenario, even the departmental structure and the chosen research fields must become more dynamic to enable the introduction of new emerging research areas, including deemphasize or entirely eliminate existing research activities within the Simula Research Laboratory.

The Evaluation Committee urges the Simula Research Laboratory leadership, in close interaction with the scientific advisory board and the Research Council of Norway, to begin a discussion of these issues with the goal to define a framework for the implementation of a long-term, dynamic department structure and scientific strategic plan. This must be flexible and open-minded enough to include all aspects of the laboratories and its activities.

2.2 Management assessment

2.2.1 Recruitment

The Evaluation Committee applauds the successful recruitment of internationally recognized research leaders as well as PhD students and post-doctoral researchers with international backgrounds. In view of the long-term health of the research activities, the committee cautions against the temptation of internally recruited researchers without international exposure for permanent research positions.

The Evaluation Committee encourages the Simula Research Laboratory to explore the employment of senior researchers on leave from Norwegian Universities in line with what is currently done with the University of Oslo. This would lead to an increased influx of new ideas and decrease the potential volatility associated with the current very close association with the University of Oslo.

2.2.2 Department organisation and research leadership

The original model for department organization with research driven leaders is showing signs of a break-down. This is caused by several factors. One is a substantial growth of one department now with close to 50 active researchers. Another is an internal personal conflict resulting in a management-driven solution. A third reason is that the environment with research, applications, and educational activities makes the whole organization more heterogeneous.

The Evaluation Committee suggests that the department leadership model should be revisited. One possible model to consider for the basic research departments is a dual leadership model with clearly separated responsibilities in scientific and managerial activities, albeit with a clear emphasis on a science driven leadership. It may be advantageous to consider a more formalized implementation of deputy department leaders to ensure leadership continuity, and to enable an improved balance for department leaders between administrative and scientific duties.

The Evaluation Committee favours recent initiatives to formalize management training of the senior leadership, but encourages the development of initiatives to ensure leadership continuity.

3. Research department evaluation

In the following, we will present a more detailed discussion of the three main research departments currently at the Simula Research Laboratory. This also contains background for a number of department specific recommendations discussed previously.

3.1 Networks and Distributed Systems Department

The Networks and Distributed Systems Department is structured into four different projects namely ICON, RELAY, REPAIR and RWN. The ICON project is focusing on scalable interconnection networks for high-performance computers and systems. The RELAY project investigates quality-of-service (QoS) and quality-of-experience (QoE) in distributed systems,

in particular, multimedia systems over the Internet. The REPAIR project addresses the problem of reliability of the Internet by improving recovery and repair mechanisms on the routing level. The issue of resilience and QoS in wireless networks is investigated in the Resilient Wireless Networks (RWN) project by looking into cognitive radio and cross-layer approaches.

3.1.1 Assessment of department's scientific contributions

The main scientific achievements of the ICON project have been in the area of topology-agnostic routing in interconnection networks to achieve high robustness and performance. The ICON project has, in an impressive way, produced both high-quality publications, e.g., in IEEE Transactions, and research results that have been relevant for practical applications resulting in various take-ups of the Simula Research Laboratory developed by industrial companies. Moreover, the Sunrise project, funded 50 % by Sun Microsystems, will ensure the industry-oriented research approach in the near future. Topics that may become more relevant for ICON in the future are virtualization and cloud computing. Overall, the research quality of ICON continues to be excellent during this evaluation period. ICON has a clear strategy and a vision for the future.

The RELAY project has been transferred from the University of Oslo to the Simula Research Laboratory during this evaluation period. The common goal of the various research projects is to optimize the quality of communication in networked multimedia applications. The publication activity does not reach the level of the ICON project, but several good conference publications (e.g., IEEE Infocom, NOSSDAV) resulted from the RELAY project. More emphasis on high-quality journals and conferences should be encouraged to increase impact and visibility. RELAY has attracted a very good number of externally funded projects (mainly by RCN Verdikt), which has allowed a significant increase of the project staff size and project diversity. The work on optimizing TCP for streaming applications is a good example of high-quality research that has interesting industrial applications. The SimTel activity between Simula and Telenor is another example of joint research with industry partners. The Lividi spin-off is a direct result from RELAY project activities as well. Within RELAY, many different activities are performed ranging from TCP optimizations via middleware for multimedia systems, to multi-core support for multi-media applications. The strategy, vision, and

scientific focus are less clearly defined than by ICON. Overall, the RELAY project can be judged as very good.

The research goals of the REPAIR project are much more focused. REPAIR emerged from the former VINNER project. It is addressing resilience in the Internet by investigating recovery and repair mechanisms at the routing protocol level. Despite the small size in terms of staff, the project has an impressive publication record during the evaluation period, e.g., papers in IEEE Transactions, IEEE Infocom, and ACM Conext. Research results have been transferred to a spin-off company called Resiliens. Future activities aim to investigate resilience in overlay networks; although this topic may have already been addressed quite well by the international research community. It should also be considered whether more fundamental research questions in the context of Future Internet research programs should be introduced. This may also suggest a focus on more long-term research questions and addressing clean-slate Internet research. Due to the excellent scientific output, the quality of the project can be considered as very good.

Despite the recommendation of the previous evaluation to focus on two projects in the Networks and Distributed Systems Department, a fourth project called RWN (Resilient Wireless Networks) has been formed. Based on the previous work of the RWN project leader, an impressive publication record has already been achieved including many journal publications, IEEE Globecom and ICC conference papers. The project needs to strengthen its industrial liaisons. A good basis is the collaboration with Telenor on cognitive radio issues. The vision for the future seems to focus on cognitive and cross-layer approaches and integrating sensor networks with wireless communication networks. Whereas current research activities are mainly driven by analysis and simulation, real implementations to validate feasibility of concepts may likely be required in the future. This would require more test-bed activities such as an in-house wireless test-bed. Due to the strong publication record the project can be considered as very good from an overall perspective.

Current networks are increasingly consisting of both wireless and wired sub-networks. A common department-wide topic of interest seems to be reliability and the robustness of (wired/wireless) network environments. A stronger cooperation across the various projects

should be able to exploit synergies in a better way. Currently, the various projects are performing research work rather independently from each other.

With one excellent and three very good projects, the Networks and Distributed Systems Department can be considered as performing very well overall.

3.1.2 Adequacy between production and financing

Overall, the Networks and Distributed Systems Department has a very good research output in terms of publications and technology transfer. It has attracted several new projects funded by external resources (RCN Verdikt, industry). The Evaluation Committee appreciates the focus on CORE-ranked conferences; although care should be taken not to overestimate the CORE recommendations. Quantity and quality of publications from the Networks and Distributed Systems Department have improved significantly compared to the previous evaluation. Several department members have been very active in research community services such as technical program committees and conference organizations. The department increased the number of graduated Master students, while the number of graduated PhD students continues to have some potential for further increase to reach a target of one graduated Ph.D. student per year and senior researcher.

3.1.3 International cooperation

Although all the projects have good international visibility by journal publications and active conference participation, international collaboration is an issue that requires further improvements. This includes the establishment of European projects, but also active participation in international working groups, e.g., COST actions, research fora etc. Sabbatical and visiting researcher programs in both directions should be strengthened.

3.1.4 Recruitment

The recruitment of qualified people has clearly been successful. New international senior researchers such as Yan Zhang have been recruited. There has been a total increase of foreign senior researchers and post-doctoral fellows to four. Improved international visibility will further improve the situation. There is currently no female post-doctoral fellow or senior researcher in the Networks and Distributed Systems Department.

3.1.5 Balance between categories of employees

The overall balance between categories of employees in the department is reasonable. There are currently five senior researchers (including those employed by the SimTel project) and five post-doctoral fellows. In some projects, improvements are possible in particular at the PhD student and post-doctoral fellow level. The REPAIR project does not have a senior research leader. However, the post-doctoral fellow is highly productive in terms of research output. Post-doctoral fellows are missing in the RELAY project. This is compensated by a higher number of senior researchers there. In total the department has 15 PhD students.

3.1.6 Department organization

The different projects are somewhat unbalanced in terms of size and diversity of research topics. While ICON, REPAIR and RWN have a strong and concise focus on a particular research topic, RELAY appears as a collection of many different research activities. The links between the projects remain weak, and the research seems to be performed in a rather independent way without benefiting from many possible synergies between projects. Grouping the projects in the Networks and Distributed Systems Department seems to be organizationally motivated, rather than through the existence of common research interests in line with the overall vision of the Simula Research Laboratory. Due to the increasing importance of the Internet Protocol (IP) for interconnecting distributed high-performance systems and components, and the emergence of cloud computing where computing resources are interconnected via the Internet, stronger thematic links between ICON and REPAIR should emerge. It is, however, likely that similar opportunities for synergies and collaborations exits between other projects within the department.

3.1.7. Scientific leadership

The leadership of the Networks and Distributed Systems Department has changed in 2008. The current leader is an experienced researcher in the field. The integration of the different activities and projects within the Networks and Distributed Systems Department, the exploitation of synergies between the projects, and the development of a common vision for the overall department, is a big challenge for the near-term future. The REPAIR project is not led by a senior researcher but by a post-doctoral fellow. This could be considered as a problem for supervising PhD students. An additional complication in the leadership situation

is that the former department leader is now the director of basic research but remains an active researcher within the department. While this is an unusual arrangement it can work as long as responsibilities are clearly defined.

3.1.8 Research plan and strategy

The lack of a clear and common overall long-term strategy for all projects of the Networks and Distributed Systems Department is emerging as a major challenge for the future. The Evaluation Committee recommends identifying synergies and common strengths across the various research projects in order to develop a common long-term strategy.

Although the Simula Research Laboratory has as a goal to transfer research results into practical and industrial applications, one should not limit the focus to research problems that arise from concrete problems driven by applications and industry partners, but actively explore new basic research fields with the long-term potential for technology transfer. For example, the international research community is currently discussing the design of the Future Internet in international basic research programs, including clean-slate approaches. The Networks and Distributed Systems Department is well positioned to more actively contribute to such programs and developments. The Evaluation Committee recommends that the Networks and Distributed Systems Department address longer-term research questions as essential and substantial components of all projects.

The establishment of stronger international relations to other research groups and research projects should be a central goal for the future. This also includes the participation in international test-bed activities.

3.2 Scientific Computing Department

The Scientific Computing Department has been an integral part of the Simula Research Laboratory since its inception, originating in a research group at the University of Oslo, then led by Aslak Tveito and Hans-Petter Langtangen, both of whom remain deeply involved in the Simula Research Laboratory as the managing director and the head of the Scientific Computing department, respectively. This long-term and sustained strong academic

leadership continues to shape the research activities in the Department, and has allowed the department to focus on advancing its research activities. It also continues to develop the vision for the department.

Since the last evaluation, the department has undergone a substantial expansion in the number of researchers to 46; with 12 in part time appointments and with the number of research groups increasing to 7 identified research units. Substantial parts of this expansion have been driven by the successful application for a Norwegian Center of Excellence (CoE) lead by Hans-Petter Langtangen, and by the development of a long-term research partnership with StatoilHydro.

3.2.1 Assessment of department's scientific contributions

The primary scientific focus of the department continues to be on the building of complex mathematical and computational tools to efficiently and accurately solve important problems in the applied sciences and engineering areas of significant value to Norwegian industry. The potential for impact on Norwegian industry and research is substantial through the important education of computational scientists, and by lifting the international visibility of the quality of Norwegian led science.

Since the last evaluation, the Scientific Computing Department has expanded significantly both in size, and in the breath and depth of its research activities. In 2004, the primary focus of the department was biomedical modelling and in the development of robust and flexible software environments for solving partial differential equations. Apart from the specific application focus, a broader and more general focus is identified as the development and applications of computational methods for multi-scale, multi-physics problems. This remains a key research area of broad and deep importance across the applied sciences, life sciences, and engineering.

Not only has the department continued to maintain these research activities during the last 5-year period, but it has been able to expand these activities in both quality and quantity. A major driving force in this growth has been the successful application for a Center of Excellence (CoE), granted in 2007. This allowed an increased focus on biomedical

computation and was further strengthened by the hiring of two senior researchers along with a substantial growth in postdoctoral fellows and PhD students.

In parallel with this substantial growth in biomedical computation and the development of open source software infrastructure/computational middleware, the department has undertaken a new geophysical modelling direction enabled by close and very fruitful research driven collaborations with StatoilHydro. The application focus is on computational geoscience, but the inherent multi-scale, multi-physics nature of such problems makes this new research direction less of a stretch than one may think in light of the past biomedical application focus In other words, there is every reason to believe that this new research initiative can benefit from the ongoing extensive activities in biomedical modelling and computation, and that the cross-fertilization between researchers in the two groups may be of significant mutual benefit.

The Evaluation Committee was extremely impressed by the breath and depth of the research activities in the department, and by the clear evidence being presented, that the rapid expansion of the department over just a few years had not resulted in any dilution of the quality and quantity of the research. This is a clear sign of a strong scientific base of active and involved researchers, supported in the process by a well-qualified group of scientific leaders with a clear vision.

In the 2004 evaluation, the group was rated as excellent, and the Evaluation Committee finds that the scientific breath, depth, and overall quality of the department have been maintained and even strengthened further. It remains an excellent research department with a growing potential to significantly impact Norwegian industry in general, and the health and energy industry in particular. Furthermore, its high scientific level and strong leadership provides excellent international visibility to the department, the Simula Research Laboratory and Norwegian research in general, and likely offers increased opportunities for recruitment of students and researchers.

3.2.2 Adequacy between production and financing

During this evaluation period, the Scientific Computing Department has grown significantly in size, mainly due to the successful application of a 10-year Center of Excellence focused on Biomedical Computation, and the development of an intense research based-partnership with StatoilHydro, focusing on Computational Geophysics. Both of these contracts are still in their initial years of activity and the impact of the growth on the scientific production is just beginning to show, e.g., the number of published and accepted journal papers for 2009 is already on level with the production in past years, and it is reasonable to expect a substantial growth during the next years.

The production in the department is further increased by the successful application of two Outstanding Young Investigator (OYI) from the Research Council of Norway to project leaders Joakim Sundnes (2004) and Anders Logg (2006). Both of these young researchers have contributed substantially to the overall level of activity in the department.

The Evaluation Committee is impressed by the exceptionally high scientific production, including books(6), journal papers(84) and high-level conference contributions (44), as well as the dedication to many other scientific activities such as the teaching and advising of students, memberships of editorial committees (10), and the development of close research-based industrial partnerships and collaborations.

While the department has been highly successful in attracting substantial funding for new projects, the number of PhD students is still viewed by the Evaluation Committee as being low. It is recommended that funds be sought to address this, or that the use of current funds be reprioritized to the extent possible.

3.2.3 International cooperation

Due to the sustained excellence in research, the department enjoys significant international visibility. This results in strong international collaborations with scientific discipline leaders across the world and the formal association of some of these as adjunct research scientists. Furthermore, the department has a strong history of recruiting and retaining international

postdoctoral and senior researchers, thereby increasing the potential for international outreach and impact.

A weak point of the department, indeed perhaps the only genuinely weak point in an otherwise excellent department, is it lack of internationally funded research activities, either through EU projects or through the formation of other international research partnerships. Given the scope, size, and visibility of the department, the Evaluation Committee finds this to be both surprising and disappointing. However, the committee also acknowledges that the Simula Research Laboratory as an organization is well aware of this shortcoming, and that several significant steps have recently been taken to address this concern.

3.2.4 Recruitment

During this evaluation period, the department has made two successful hires at the senior level. One is Kirsen ten Tusscher, thereby significantly strengthening computational biology and adding expertise in systems biology, and the other being Anders Logg, adding substantial additional expertise in computational mathematics and software development. Both are excellent recruitments of international researchers, adding to the core activities and expertise in the department. The Evaluation Committee commends the department for pursuing excellence, rather than more narrow national interests in hiring senior researchers.

Additionally, the department has been successful in recruiting postdoctoral researchers with a broad international background, adding to the intellectual diversity and strength of the whole department.

The department has also had some reasonable success in the recruitment of MSc students with about 25 students having finished during this evaluation period. These students are, however, almost exclusively recruited from the University of Oslo. The Evaluation Committee finds this situation to be unfortunate, as a broader recruitment base would likely allow the department to increase the total enrolment to the benefit of the students, the department activities, and the Norwegian society as a whole.

3.2.5 Balance between categories of employees

Among the 35 full time scientific staff, there are approximately 9 senior researchers, 10 postdoctoral researchers, and 12 PhD students. Additionally, there are some scientific programmers and some administrative personnel as well as approximately 5 MSc students on an annual basis. While the number of senior and postdoctoral researchers is well balanced and the department is functioning well as a unit, the Evaluation Committee feels that the department should be able to successfully absorb and educate a larger number of MSc and PhD students. These will not only benefit from the stimulating environment in the department, but will also expand the impact of the Simula Research Laboratory to the benefit of Norwegian industry and research. While the committee appreciates that there are financial implications associated with a significant expansion of the number of PhD students, it recommends that such an expansion be given some priority. Furthermore, a focused expansion in the recruitment base to include other Norwegian universities should also allow for an increase in the recruitment of MSc students.

3.2.6 Department organization

The department is organized in 7 individual research groups of varying size with the largest having close to 10 members, and the smallest consisting of just 3 members. The larger groups are primarily focused around research activities driven by the Center of Excellence activities in biomedical simulation and flow solvers, and the more recent emphasis on computational geoscience. All project leaders report to the department head.

While all 7 projects are active and productive, it appears the smaller activities are driven largely by the interest of individual researchers, rather than being developed with an eye toward a larger common goal. The Evaluation Committee finds this to be of some concern, as this appears to contradict the foundational vision of the Simula Research Laboratory, formed to allow large groups of researchers to work collaboratively toward large-scale “Grand Challenge” problems through long-term directed research. The formation of smaller groups to accommodate individual research interests and activities not only dilutes the difference between the Simula Research Laboratory and more traditional university based research groups, but it also makes such research activities and investments volatile to even minor changes in staffing.

The Evaluation Committee was impressed with the strong interaction between the individual projects. However, the committee also believes that the Scientific Computing Department is approaching a size, and a level of activity and diversity, where the Simula Research Laboratory model of having research active leaders in a flat organization, is likely to become increasingly challenged as a successful model. The committee encourages the leadership to begin a discussion of suitable models to address this concern, including a focusing of the research through the elimination and absorption of smaller projects, deputizing the department~~,~~ or a genuine split of the department.

3.2.7 Scientific leadership

The Scientific Computing Department has had some changes in senior leadership during this evaluation period during which the past head, Aslak Tveito, has assumed the role of managing director of the Simula Research Laboratory. He was first replaced by Joakim Sundnes until 2007 when the establishment of the Center of Excellence led to Hans-Petter Langtangen assuming the role as the department head. Langtangen has been involved since the formation of the Simula Research Laboratory and his seniority, high scientific productivity, and international visibility is likely to continue to provide a strong scientific leadership to the department.

3.2.8 Research plan and strategy

The short term research plans of the department are focused on expanding and solidifying the ongoing efforts. In particular, the research driven software development and its dissemination as an open source project. This is complemented by a continuation of the application of this infrastructure, to complex problems in biomedical and geophysical modelling. The emphasis will continue to be on longer-term research driven activities, rather than on short term, publication driven activities in line with the overall vision of the Simula Research Laboratory.

The department is well positioned to execute this short-term focus, and it has the potential to have a significant impact in some of these applications. However, it is increasing likely that a gap between more academic applications and those of truly realistic complexity will emerge due to the limited direct contact with application scientists so far. An indication of

this is the low number of publications in medical journals, in spite of a substantial long-term effort in biomedical modelling. The Evaluation Committee is mindful that the department has worked hard during the last few years to increase direct collaborations with medical institutions and hospitals, and a growth in publication activity during the next period can be expected.

An indicated longer term goal of the department is a much more substantial move in this direction, moving from discipline specific modelling efforts to what can be characterized more broadly as computational science, encompassing a deep and fully integrated approach to modelling, simulation, and the application science. Such a change will likely drive the activities in the department away from the development of more fundamental computational and mathematical tools, and toward areas related to data-driven science, data-assimilation, uncertainty quantification and management, and the extensive validation of complex models. While these are natural and important directions of research, they also involve a significant digression from existing activities. It is unclear how the department is planning to address this concern without adding substantial new resources.

The Evaluation Committee recommends that more specific longer-term plans with rolling renewals be developed, including an ongoing evaluation of all research activities and projects. This would seem to be particularly important if the department leadership foresees a need to redirect substantial resources in the department, to transition toward a more general focus on computational science.

The Evaluation Committee wishes to emphasize the need of the department, and the Research Council of Norway, to be mindful of the emerging challenge of having to carefully balance long-term, high-risk fundamental research with short-term activities, most often funded through external contracts and industrial partnership. Both activities need to co-exist to maintain an attractive environment of cross-fertilization between the activities, and to ensure the successful infusion of deep research-based developments into large-scale complex applications. On the other hand, the shorter-term efforts are often easier to fund, but are more likely to yield limited results of a fundamental and lasting value. The unique qualities of the Scientific Computing Department, and indeed, the Simula Research Laboratory itself hinges on maintaining this balance. The Evaluation Committee cautions

that maintaining this balance likely requires ongoing and careful attention to all aspects of the research enterprise.

3.3 Software Engineering Department

3.3.1 Assessment of department's scientific contribution

The Software Engineering Department at the Simula Research Laboratory was created in 2001 with a focus on empirical Software Engineering. The department chose to devote its resources to conduct large empirical studies with the goal of quantifying and understanding the effects of using various models, methods, techniques, tools and process models in different industrial situations.

The results of this strategy have resulted in a substantial pay-off during the last five years. Findings of the large empirical studies conducted by the department have brought out empirical evidence that has had a considerable impact on the entire software engineering community worldwide, both in academia and in the professional arena. The methodology applied to carry out these large experiments of various types has radically changed the views and expectations of the empirical software engineering researchers. The department is well known for its intensive use of controlled experiments, has advanced the state-of-the-art regarding realism and scale of empirical studies, and is regarded as a model by all other research groups that need to set such experiments.

The Evaluation Committee is impressed by the quality and value of the research, and considers the scientific contribution of the Software Engineering Department to be excellent. One measure of the importance and quality of results is that the scientific papers written by the department are readily accepted by the most prestigious journals such as IEEE TSE, IST, JSS, IEEE Software, etc. They are also frequently cited, e.g., the 5 most cited papers of the department are among the 20 most cited software engineering papers since 2002. Another valuable example of the Software Engineering Department is its ranking as third among 1361 institutions worldwide in the most recent assessment of systems and software engineering scholars and institutions.

The ultimate goal of software engineering research is to support practical software development. The department currently targets some specific areas in software engineering, specifically software cost estimation, evolution and maintenance of object-oriented software, testing and inspection, and model-driven development.

The Evaluation Committee considers that the interplay between empirical study and methodological research that characterizes the organization of researchers in the department is an excellent approach; a unique feature and a key reason for its success and strength. The committee encourages the group to maintain this approach in the future.

Finally, this evaluation period has provided strong evidence that the Software Engineering Department benefits Norwegian industry by providing research results that influence the work processes of the software industry. By educating software practitioners through a well attended annual seminar, and by engaging in collaborations with Norwegian companies, the Evaluation Committee strongly encourages that such collaborations continue and expand.

3.3.2 Adequacy between production and financing

The department has conducted an impressive number of controlled experiments and other studies involving industrial participants. Since 2001, 262 companies from 24 countries, consisting of 2730 professionals have participated in 154 experiments. The department is the first with extensive use of multi-country populations in software engineering experiments.

The department produced 47 journal papers during the evaluation period, hence doubling the production from 2001-2004.

These are exceptional achievements when considering the international impact of the findings of the experiments and the increase in the number and the quality of the publication. The international research community has acknowledged this excellence in many different ways; ranking of the Software Engineering Department as the 3rd among 1361 peer institutions, ranking two of the researchers as 1st and 4th best scholars, several 'best paper' awards, and several best cited papers.

The Evaluation Committee suggests that the department strives to increase its budget to extend its activity. This is particularly important, as the activity has, and will, continue to have a significant impact on the Norwegian software industry.

3.3.3 International visibility

The Software Engineering Department has significant international visibility, particularly in the empirical software engineering research community. They have established worldwide cooperation with the main research units conducting empirical research on software engineering. The department is an active member of ISERN, which is the primary network for empirical research on software engineering. The Evaluation Committee encourages the department to further strengthen international cooperation to establish stable and long-term relationships with research units abroad enabling the exchange of researchers and faculty, as well as PhD students. It also suggests an increased participation in EU projects, and encourages them to take the lead on a proposal to create an EU Centre of Excellence on Empirical Software Engineering.

3.3.4 Recruitment

The department has grown from 14 members in 2004 to 19 in 2009. The department recruited internationally known scientists-Lionel Briand, Dietmar Pfahl and Leo Moonen. This is likely to further increase the attractiveness of the department when recruiting international PhD students and postdoctoral researchers. Seven of the 18 full-time scientists were recruited internationally.

The Evaluation Committee applauds the international recruitment that demonstrates the visibility of the Simula Research Laboratory in general, and of the Software Engineering Department in particular. This is critical to bring new ideas, new cultural thinking, and possibly new research vision to the department.

The committee believes that the policy to employ professionals to manage the experimental studies is a good one; it avoids research leaders being distracted from their main research activity.

3.3.5 Balance between categories of employees

The group consists of 8 full-time researchers, 10 PhD students, 1 postdoctoral fellow and 1 visiting part-time researcher. Although not particularly large, the group has a good balance of employees and is of a sufficient critical mass. The committee suggests an increase in the number of Post-doctoral fellows and PhD students recruited internationally.

3.3.6 Department organisation

The department is organized around 4 projects/research groups that correspond to the software engineering areas by analyzing the observed engineering practice proposing theories, models, methods and tools to improve the current practice. These groups are relatively small in size (5 people in average).The advantage is that the groups are focused with little administrative overhead. The disadvantage, however, is that the groups are vulnerable to minor changes in staffing. Given the relatively small size of the groups, it may be important to recruit new academic staff to maintain their continuing critical mass.

During the evaluation period, the testing group was created due to the recruitment of Lionel Briand. Testing and model-driven development are important and timely topics in software engineering to which the group can contribute significantly. This may require increasing the number of PhD students and recruiting postdoctoral fellows.

Some strategic planning is necessary to determine; which key research areas need focussing for the next forthcoming period; a possible new group to deal with new areas of software engineering; or the termination of some groups. Requirements Engineering was mentioned as a possible new subject, and the Evaluation Committee encourages the group to move in this direction. Requirements Engineering is substantially impacting the success of projects and the quality of the end product. Understanding and improving requirements engineering practice might have a significant impact on software development.

3.3.7 Scientific leadership

The original model for department organization was based on senior research driven leaders in the field to provide the long-term scientific vision and assuring its implementation in a directed manner. Due to an internal personal conflict in the Software Engineering

Department, the model in place today is more of a management-driven solution. The Evaluation Committee wants to stress that the scientific production has not been affected by this problem. However, the committee is concerned by the change in the leadership model and suggests that this model be revisited. One possible model to consider is a dual leadership model with clearly separated responsibilities in scientific and managerial activities.

3.3.8 Research plan and strategy

The 2004 Evaluation Committee appreciated the way in which the research plan was presented as a "Grand Challenge". While it is remarkable to notice that the goal has largely been attained, the department now appears to have entered into a consolidation phase to maintain the goals of conducting empirical studies, and to produce research results leading to substantial improvement of software development productivity and quality. This Evaluation Committee agrees that it might be appropriate to continue with the current directions at present. However, we would like to suggest that the department initiates a more critical discussion of the likely evolution of the target areas on a longer time-scale, and considers the possibility of a rolling research plan that takes into account the evolution of challenges in software engineering and adapts the project structure accordingly.

3.4 Research Application

3.4.1 Skills in planning exploitation

The Simula Research Laboratory has developed its organization for the commercial application of the research since the last evaluation. A department for "Research Application" has been formed of which Simula Innovation is a part. The organization still appears to be under development, but has already had some positive instrumental effects for activities of the Simula Research Laboratory within this field. One example is the establishment of seven spin-offs. These seven units were helped in taking the first steps to become established commercial companies. Six are typical spin-offs, while the seventh, (Kalkulo AS), is characterized by the separation of consulting activities that the Simula has become involved in. Some of these were with the industrial partners. The Simula Research

Laboratory, has in this way, managed to initiate the difficult process of increasing its own ability to find direct commercialisation opportunities of research results. It is difficult because such processes are highly uncertain and influenced by several random factors.

More importantly is that the Simula Research Laboratory as a totality has become more systematically related to some advanced commercial users. This has taken place through the development of "close and strategic research relationships" with a number of key industrial collaborators within the Norwegian business world. StatoilHydro is the prime example, but Telenor and DNV are two other good examples. A positive feature with these relationships is that they involve different research groups within the Simula Research Laboratory. They are not concentrated in just one group or in one area. It is impressive that the Simula Research Laboratory has managed to establish and implement these relationships in a relatively short timeframe, and they will certainly stimulate the research activities in a positive way as long as they do not develop into pure consulting relationships. The separation from the commercial unit Kalkulo AS, that today is responsible for the commercial part of the StatoilHydro relationship, is an important long term organizational way of handling this issue. The most positive scenario is that the commercial users will become very advanced users forcing the researchers to formulate not just challenging, but also commercial interesting problems where different types of contexts are systematically built into the research models. Such a process may well result in the researchers attaining an even higher level of competence.

On the other hand, a negative scenario is that the Simula Research Laboratory over time becomes more economically dependent on these users, resulting in the research problems becoming too commercial, and thereby too short term based. Thus, Simula needs to develop its ability (a relationship model) to organize such cooperation in order to continuously vitalize and keep their research focused. This can not be done by a separate department but must include all participating parties. This is probably the most important long-term issue in relation to increased commercial exploitation of the research conducted at the Simula Research Laboratory.

Furthermore, it is now also time for the Simula Research Laboratory to develop a comprehensive and strategic picture of the number and the distribution of such relationships. It is certainly one of the best ways to successively become more involved within the Norwegian business network, and the commercial implications may become huge. One challenge from the point of view of the Simula Research Laboratory is to identify indicators of these commercial implications, as most of them are indirect and more or less impossible to measure through simple commercial indicators. One possibility can be to measure the activity that is created within the industrial partners (for example, man-year invested in these projects by the partners).

The Evaluation Committee supports the development of the Simula Research Laboratory based on research relationships as the main means for increasing research applications. The strategic goals should be formulated accordingly.

Financial resources for two types of activities important to the Simula Research Laboratory may be identified. One is for covering the research activities conducted in relation to commercial users, and the other to cover the development costs for single commercialization projects. The "research relationships" can be used for covering both of these expenses as exemplified by the StatoilHydro partnership in an interesting way. Such a relationship may also help the Simula Research Laboratory to cover its own research costs. However, if this is emphasized too much it will drive these relationships in the wrong direction – they will become consulting relationships. Thus, it is more important that the external partners invest in the development of their own personnel to use research results, as well as invest in the development of different applications, i.e. the second type of activity. So far, this has worked in an excellent way; at least in the StatoilHydro case.

Raising financial resources for separate and stand-alone projects (risk capital for spin-offs) is a more specialized and unique task, and requires very specific and well developed business ideas. Up to now, the Simula Research Laboratory has managed to mobilize some extra resources from the Research Council of Norway to arrive at this situation. As a consequence, the resources used for the development of single products have been time invested by involved researchers/entrepreneurs in addition to the examples from the StatoilHydro

relationship. It is questionable whether the Simula Research Laboratory, given its limited size, should try to become more than an interesting and valuable idea-producing partner for other business development agencies or venture companies.

3.4.3 Marketing knowledge

This can be divided into three different parts. The first and the most important is the knowledge required to develop close research relationships with advanced commercial users as described above. Here, the Simula Research Laboratory has demonstrated an excellent but mainly tacit ability. The next important step is to find a way to make this knowledge more explicit in order to increase the learning-by-doing.

The second part is the knowledge required to market commercial ideas in relation to investors or potential business partners. The activities during the last years indicate that the Simula Research Laboratory has at least reasonable skills, and these will successively increase through learning by doing. However, the Evaluation Committee suggests that learning could be enhanced and accelerated by increasing the experience exchange with similar organizations internationally. Today there are several similar organizations with ten to twenty years of experience.

The third type of marketing knowledge regards a specific field for each application. It can, for example, be medical equipment or an oil exploitation. The Simula Research Laboratory has little or no such knowledge and probably never will. It will always be reliant on business partners for this type of knowledge.

3.4.4 Contact with investors

The establishment of a special organization, and the hiring of professional personnel, has increased the ability of the Simula Research Laboratory to develop a suitable investor network. Still, the Simula Research Laboratory has a long way to go to attain an established network.

4. Research Education

4.1 Goals for research education

The activity within the education area has been substantially extended during this evaluation period. The number of active PhD students has increased from 24 to 36 with a goal of 45. One major difficulty is the funding, as the cost for each student is approximately 2.4 million NOK. This is an issue that the funding authorities will need to consider for the next period. The Evaluation Committee supports the overall goal of 45 active PhD students. This seems to be a very reasonable target. It is also a realistic and attainable goal that will not hamper the major focus of the long term research focus.

4.2 Strategy for research education

The Evaluation Committee finds the creation of SSRI to be a very good development. It has given Simula the needed organisational means to create a stimulating education environment within the Simula Research Laboratory, and at the same time, to become an identifiable partner for other educational units within Norway and internationally. The PhD students have a clear organizational entity, and it will facilitate that the educational process becomes more structured and hopefully also more efficient. Additionally, it is also providing a base from which the PhD program can continue to develop.

4.3 PhD program

The development of SSRI has created opportunities to develop some special PhD courses. Currently, this activity has been oriented toward complementary fields, such as the presentation of research results, and the interface between scientific research and innovations. The Evaluation Committee suggests that this activity be expanded to include more central research courses where the Simula Research Laboratory can develop and distribute advanced PhD-courses within its core fields to several other research departments in Norway and abroad. Such activities could also include summer schools and other intensive activities. These activities can be used as a complementary way to identify and develop joint projects between the Simula Research Laboratory and other research departments.

4.4 The role of the PhD program

The creation of SSRI has given the education field a substantial base within the Simula Research Laboratory, but remains in the development phase. There are several interesting development possibilities that the Simula Research Laboratory has to consider. One such possibility is to use new PhD students to explore new complementary research areas. Most of the PhD students will be recruited directly to the projects in the future, but there should also be opportunities to hire highly qualified students who, during the first year, develop their own projects in interaction with several senior researchers. This type of recruitment can be used to identify complementary or even alternative research problems, as well as to explore emerging research activities.

The PhD program is also a means for increasing the application of research results. An important accomplishment is when the doctors from the Simula Research Laboratory program today, at least to a certain extent, are finding interesting jobs in the industry. Here the developed research cooperation with industrial partners can play an important complementary role.

5. Evaluation Committee membership

Professor Torsten Braun	University of Bern, Switzerland
Professor Jan S Hesthaven	Brown University, USA
Professor Håkan Håkansson	BI Norwegian School of Management, Norway
Professor Colette Rolland	University of Paris I, France

Appendix A: Mandate for the Scientific Evaluation

Simula Research Laboratory AS (Simula) was established in 2001 as a limited company with the Norwegian Government as the principal shareholder. The company is a not-for-profit, public utility enterprise. The company's objects are to engage in basic long-term research in selected areas of software and communications technology and, by so doing, to contribute to revitalisation and innovation in business and industry.

The objective of this evaluation is to give the Research Council of Norway an impartial and complete report on the activity at Simula. The evaluation will be used as a basis for determining the future funding, status and organization of the centre.

The evaluation of Simula has been split into two parts:

1. **The Scientific Evaluation**: An evaluation of the quality of the research conducted in the center
2. **The Concept Evaluation**: An evaluation of Simula as a new concept in the Norwegian R&D system

In order to define the boundary between the two evaluations, the mandate for the Scientific Evaluation is concentrated towards scientific issues and the scientific leadership at Simula. These issues are general in the sense that they are approximately the same for all research departments or research groups. In general, they are independent of how the department or group is organized, and usually independent of whether or not the department or group is a part of a larger research organization. Issues of relevance that do not belong in this setting shall be addressed in the Concept Evaluation.

The rest of this document specifies the mandate for the Scientific Evaluation.

The findings of the Scientific Evaluation should be presented in a written report. The evaluation should cover all parts of Simula including Basic Research, Research Application and Research Education. It should also cover:

- the scientific results achieved in the centre,
- the innovation results achieved as a result of the research at the centre,
- the scientific plans for future research at the centre,
- the international collaboration including participation in EU-projects,
- the research leadership,
- the policies guiding recruitment and handling of employees including aspects of gender equality,
- the organization of Simula with respect to the research done at the centre.

We specifically ask the committee to address the following issues:

Simula Research Laboratory

1. Does Simula conduct research at an international level?
2. Does the research at Simula address topics that are accepted as important internationally?
3. Is there a satisfactory degree of scientific cooperation between Simula and international and national research centres?
4. Is Simula's participation in the European Framework Programmes satisfactory?
5. Is Simula's contribution to education of MSc and PhDs in informatics satisfactory?
6. Does Simula appear to be an attractive research partner for the best researchers in Norway and internationally?
7. Is the research done at Simula relevant for Norwegian industry and society?
8. Has Simula worked actively to promote the establishment of businesses based on the research in the lab?
9. Comment on the research plans for the next five years.

Basic Research

1. Present an assessment of each department's scientific contribution.
2. Is the scientific production reasonably large in view of the available financial resources?
3. Does the department actively cooperate with international research groups?

4. Is the recruitment of scientists to the department satisfactory?
5. Is there a reasonable balance between various categories of employees; PhD students, postdocs, researchers and professors?
6. Is the department organised in a reasonable manner?
7. Is the scientific leadership working properly?
8. Comment on the research plans and strategy for each department.

Research Application

1. Does Simula possess the necessary skills to turn research into business?
2. Does Simula have the ability to obtain the necessary financial resources?
3. Does Simula have access to people with sufficient market knowledge?
4. Does Simula have good contact with investors?

Research Education

1. Does Simula have realistic goals for its research education activity?
2. Does Simula have a good strategy for achieving its goals with respect to research education?
3. Is the PhD program well defined?
4. Does the PhD program contribute to other Simula activities in a satisfactory manner?

The Scientific Evaluation should be based on:

- The research plan for Simula
- The evaluation of Simula from 2004
- Annual reports from Simula
- A self-evaluation from Simula including lists of scientific publications and the 5 most important publications from each of the research departments. An overview of the innovation and education activities is included as a part of the self-evaluation.
- A plan for the scientific activity in Simula for the next 5 years
- A site visit to Simula

Part II

Concept Evaluation

Erik Arnold, Knut Conradsen, Suzanne Lacasse, Gunnar Öquist

October 2009

Summary

This is an evaluation of Simula **as a concept**. A separate scientific evaluation has been undertaken.

Simula was set up as an independent fundamental research organisation in 2001, with substantial core funding from Norwegian Departments of State as part of a larger project to create an ICT-based science park on the site of the former Oslo airport at Fornebu. That project has met with limited success, but Simula has built capacity in comparatively new fields and established itself as a strong research-performing institution doing excellent science.

In research policy terms, Simula is important because of its role as a change agent in relation to the university and research institute system in Norway. The education ministry (now KD) decided there was a need to establish new areas of ICT research more quickly and at larger scale than the university system could deliver and that establishing an institute outside that system would encourage its modernisation. It represents the start of a process of focusing research-funding resources on creating change and building critical mass in the previously fragmented university research system.

Simula has made good use of the freedom afforded by its position outside the university and research institute system to build a strong staff and good international visibility through publications. It would benefit from stronger support from the Scientific Advisory Board and the Board of Directors. This lack of support, as perceived by the concept evaluation committee, is reflected in the fact that its strategy has failed to develop and to become as future-orientated as it needs to be and should have been, given the level of financial support and consequently the freedom under which Simula has operated.

Simula needs to become much more engaged in the European Framework Programme than it is today and to seek more industrial contact to help it focus its fundamental research on problems of societal and industrial relevance. The management model needs to be overhauled, because it was designed for a smaller organisation and it is now over-stretched. The limited success of the IT-Fornebu project (which was originally conceived as a science

park rather than the industry park it has become) means there is no pressing reason for Simula to remain at the old airport and it would do better, and contribute more to research synergy, if it were located close to University of Oslo ICT faculty members.

The concept evaluation committee recommends that

- Simula be required to review its management and propose a new structure to its Board and KD within 12 months
- A new Scientific Advisory Board be appointed in short order, comprising only leading foreign scientists from the fields in which Simula operates
- Simula be required to review its scientific strategy, designed to achieve renewal without loss of focus and agree the new strategy with the new Scientific Advisory Board and then its Board. The strategy is to include a demonstration of closer relationships to industry (including foreign industry) and how Simula will participate in the EU Framework Programme
- State funding of Simula should continue at the planned level for the next five years, but the 5+5 model should be discontinued. The money should flow directly from the ministries to Simula, not via RCN or UiO
- KD should continue to be the owner and should buy out the shares of the two minority owners NR and SINTEF at a fair price that does not provide windfall profits
- Simula should use the opportunity provided by the expiry of its lease at Fornebu to move close to UiO
- The owner(s) of Simula should carefully review and assign new members to Simula's Board of Directors, with a mandate to implement the two 2009 evaluation committees' recommendations.
- Simula should remain fully independent of other organisations for the next 3 years. This should be followed by an evaluation of the quality and relevance of Simula. Continuing the current level of funding should be dependent upon
  - Maintaining or increasing the current high level of scientific quality
  - Increasing Simula's contacts and cooperation with industry, while retaining a fundamental focus to the bulk of its research
  - Developing a plausible and more dynamic scientific strategy

  - Developing a system of governance that allows Simula satisfactorily to function as a free standing research centre owned by UiO
- Simula should then transition to become a free standing but internal research institute within (and owned by) UiO across the following 2 years. This should not entail any reduction in funding for Simula or UiO over and above any reduction that may be recommended by the evaluation

New instruments are needed in the research funding system that (a) support universities in making significant strategic investments in new fields and new capacities and (b) provide dis-equilibrating impulses external to the universities, where the university system is unable itself to make the necessary strategic moves. The Simula model is a good example of category (b). It needs to be used sparingly, where there is a need to build capacity in focused fields of research and alternative, more routine mechanisms are not available or are unlikely to achieve the desired effect. This is likely to be the case if the change in strategic direction is large and/or the needed research community is small and at an early stage of development.

The use of a Simula-like model need not be restricted to Departments of State. It would be equally appropriate for groups of research performers or others to set up such an organisation. Logically, those who 'own' the problem to be solved by the institute should also own it. The exception is RCN, which should not own research-performing organisations, as this would create conflict between its funding role and its ownership role. The use of the model should be triggered by a problem analysis and the willingness of one or more actors to establish and manage the required organisation. Simula has shown that the Limited Company form is well suited to this task. Individual situations have to be judged on their individual merits. But as a general principle, there should be a process of 'renormalisation' after some years where the new organisation is absorbed into the permanent structures of the knowledge infrastructure.

1. Introduction

This is one of two evaluations of the Simula Research Laboratory carried out in 2009. One has been a scientific evaluation, to whose results we refer below. This evaluation assesses Simula as a new **concept** in the Norwegian research and innovation system, which is to say that our central concern is: What lessons can we learn from the experience with Simula that would inform the future use of this type of funding instrument in Norway?[1] Of course, this is a question that depends heavily on the context, so we devote a great part of our effort to understanding the specific nature of Simula, which arose in very special circumstances.

A panel comprising the following people did the concept evaluation

- Dr. Erik Arnold, Managing Director, Technopolis, UK
- Professor Knut Conradsen, Vice-Rector, Technical University of Denmark
- Dr Suzanne Lacasse, Managing Director, Norwegian Geotechnical Institute
- Professsor Gunnar Öquist, Permanent Secretary, Royal Swedish Academy of Sciences

Our report is structured in six parts. First, we summarise the history of Simula to date. Second, we ask whether setting up Simula was an appropriate initiative in context, considering Simula's role as a change agent in the research and innovations system. Third, we discuss the performance of Simula to date. Fourth, we analyse the strengths and weaknesses of Simula as it appears today. Fifth we recommend what should now happen with Simula. Finally, we discuss the Simula concept – or Simula as an *instrument* in R&D funding, to use another terminology – suggesting when it is likely to be useful and what alternatives should be considered, depending on circumstances.

2. The Simula Story

Simula has roots in the decision to close Oslo's established civilian airport at Fornebu, close to the City centre, and to convert the military base and airport at Gardermoen into a much larger civilian airport to serve the Oslo region. A group of investors seized upon this as an

[1] Our formal mandate is appended to this report

opportunity to develop a research-focused science park, specialising in ICT, on the Fornebu site and successfully persuaded the government to join in the project. It cannot be said that the results of this initiative have been economically impressive. Simula was the intended research 'heart' of the science park. Unlike the more commercial activities, it has developed largely according to plan.

2.1 IT-Fornebu

Fornebu airport was closed in 1998. Already in 1995, Fred Olsen, a Norwegian ship owner, together with Norsk Investorforum, an industry think tank, proposed that the site should become an IT business park. The park was to be centred on a research organisation, which was intended to make it attractive for IT-based, innovative companies to locate at Fornebu. Another key plank was the idea that TeleNor (the former state telephone monopolist) would locate its R&D activity at Fornebu.

At the early stage, the main roles assigned to the state were: to establish the intended research centre, to provide appropriate planning permissions and regulation and some measure of finance. In 1997, the government gave its support to the project, on which the expectations increased steadily to include education, distance learning, distributed education in partnership with the regional colleges, cooperation with regional business incubators and other type of incubators. It was to be well networked both nationally and internationally. Potential tenants of the centre were expected to show their plans for contributing to the IT-based development of Fornebu and their leases were to contain restrictive clauses binding the activities of the tenants to the IT industry. Meanwhile, national higher education, research institutes and industry with interests in IT were all to be involved[2].

The IT-Fornebu company[3] (held by a group of industrial investors) bought the Fornebu site from the state in 2000. It was intended that the state should be part of the IT-Fornebu consortium but its entry was delayed until 2001, when the EES authorities cleared its

[2] Innst. S. nr. 232 (1997-1998), cited from St. Meld. Nr. 42 (2003-2004), Status for IT- og kunnskapssenteret på Fornebu

[3] Like many Norwegian companies, this was set up as two separate legal entities: an operational entity and a second one to hold real property

participation. At that point, in 2001, the state acquired a little under one third of IT-Fornebu – just in time to feel the force of the collapse of the 'dot-com bubble'.

Simula was established on 1 January 2001, in order to become the research organisation at the heart of IT-Fornebu idea. It was hosted by the University of Oslo's Informatics Department until it moved to Fornebu a year later.

Oxford Research reviewed the progress of the IT-Fornebu project in 2004. It noted that the project started with a vision of international networking and research, backed up by an international scientific committee, intending to become a leading science park and attractor of foreign direct investment as well as national participation. Oxford Research noted that by 2004

- IT-Fornebu had abandoned its efforts to market internationally
- With the exception of Simula, IT-Fornebu had failed to attract any research or educational activities
- The intention to become an international centre for further education and e-learning had been dropped

In effect, IT-Fornebu attracted state cooperation and financial involvement for an ambitious plan to establish a research-centred science park; but by 2004, this ambitious vision had degenerated into a process of building an IT-focused business park[4]. Simula was left as one of the few real traces of the original idea. Oxford Research found that Simula had quickly established an international reputation, but that its location at Fornebu had not played a role in this success. Simula's degree of contact with other firms at Fornebu was limited and its contacts with venture capital there even more limited. (Despite the passage of a further five years, the two aspects are little changed.)

[4] St. Meld. Nr. 42 (2003-2004), Status for IT- og kunnskapssenteret på Fornebu

2.2 Simula

An Interim Board[5] was set up for Simula for the calendar year 2000, and tasked by the Natural Sciences and Technology Board of the Research Council of Norway with establishing the Simula centre. The Interim Board established a working group, mostly comprising researchers (from UiO, NR, NTNU, UiT, UiB, SINTEF and Gartner Group) to select the research themes that Simula should pursue. Neither the Interim Board nor the working group contained foreign expertise.

The Interim Board defined Simula's vision and overall objectives, linking the need for fundamental research to industrial relevance.

> The overall task of the centre for ICT research at Fornebu is to contribute to business innovation. It is a precondition for doing this that the centre should conduct fundamental, long-term research at an internationally high level.
>
> The centre will be a recognised international player, well positioned in a network of cooperating research groups. The theme of the centre is software, methods and tools related to the development and use of network-based systems. The centre shall be dynamic and have tight links with both local and international industry.[6]

The working group consulted widely among Norwegian ICT researchers and concluded that rather than duplicate existing Norwegian research capabilities, the new centre should focus on new and exciting themes where Norway needed to build up research capacity

- Software engineering (based on capabilities at NTNU and UiO)
- Communication via heterogeneous networks (based on people from UiO)

A third theme was left open, to be defined by the incoming director. Via a head-hunter, the Interim Board sought a prominent scientist living abroad for this position, but after

[5] Helge Klitzing (Interforum Partners – Chair), Eiving Hiis Hauge (NTNU, Tor Saglie (University of Oslo), Riitta Hellman (Norwegian Computing Centre _ NR), Bjørn Lillekjendlie (SINTEF), Erling Maartmann-Moe (Cell Network ASA) and Jarle Nygard RCN - observer)

[6] Instilling fra Interimstyret, *Senter for fremragende forsking på Fornebu*, 01.10.00

negotiations broke down with only one possible foreign candidate, the Interim Board decided to appoint Morten Dæhlen from UiO. The Interim Board decided there should be an international scientific advisory board, the majority of whose members should be foreign. The Interim Board proposed that Simula should have the legal form of a limited company, with no additional restrictions or covenants. Its ownership was to be

- UiO and NTNU, 25% each
- UiB and UiT 15% each
- SINTEF and NR, 10% each

The Board was to be made up of one member from each of the owners plus one member nominated by RCN. In practice, the Education Ministry (KD) overruled the proposed ownership structure, arguing that, since the universities are legally its agencies, they could not represent the state as owners because they were liable to disagree amongst themselves, leading to a paradox where the state disagrees with itself. As a result, KD took 80% of the shares and the two research institutes (SINTEF and NR, which are organised as private foundations) took 10% of the shares each. However, the proposed Board composition was retained until 2004. The total capital issued was MNOK 1.5.

Simula was set up with a MNOK 45 budget: 25 million from KD and the 10 million each from the Transport and Trade and Industry Departments. It was evaluated in 2004, as a result of which the ministries agreed to provide rolling 5+5 year funding, with an evaluation to take place at the mid-point. In the same year, Simula established Simula Innovation as a subsidiary to handle IPR and spinouts. In 2007 (in response to the earlier evaluation), it launched the Simula School, of which it owns 56% while the local municipality and Norwegian companies hold the balance.

Simula has spun off a total of nine small companies, today retaining an ownership interest in seven of them. In most cases, the intention is for Simula to withdraw from ownership as soon as practical, since Simula does not regard itself as having the necessary skills or interest to be the best long-term owner for such companies. The exception is the largest of the spin-offs – Kalkulo – with 9 employees and a turnover of 7 MNOK, through which Simula channels

applied research and development activities, maintaining an arms-length relationship to avoid unfair competition with others in those fields.

3. The need for strategic change agency

Simula's origins are not only in the historically specific transition at Fornebu but also, and perhaps more importantly, as a response to university governance and funds distribution traditions in Norway that have made it difficult to introduce significant strategic changes.

Simula was formed at a time when – as in other countries – there was already a policy discussion in progress about fragmentation in the university research system and the need (a) to build critical mass in some areas and (b) to provoke change in a system that tended to maintain its existing structures. The evaluators of RCN observed in 2001 that

> The universities' ability to modernise at the same pace as others in Europe has been constrained by their rather traditional governance models. These models make it hard to set priorities and develop strategies. Some of the universities are more flexible in this respect than others. All the universities operate with levels of commercial funding below European norms, partly reflecting the strength of the applied institutes but partly also reflecting choices made by some of the universities. The universities are much more active partners of the state than they are of industry.
>
> RCN has been able to influence the development of university research capabilities to a certain extent through the use of strategic programmes, and the coming generation of RCN-funded centres of excellence will represent a useful continuation of this trend.[7]

In this context, Simula was seized upon as an opportunity to step outside the normal funding and governance channels in order to create new research capacity in Norway in fields of strategic importance. It represented a judgement by KD that, at the time, it was not possible or plausible to create equivalent innovation inside the universities. The job of Simula was therefore not only to do research but also to destabilise the existing structures in university research in Norway, encouraging the universities to find new ways to develop and implement strategic priorities in the future.

[7] Erik Arnold and Ben Thuriaux, *RCN In the Research and Higher Education Sector*, Background Report No 4 in the Evaluation of the Research Council of Norway, Brighton: Technopolis, 2001

There were two obvious alternatives to the Simula model. One was to allocate more block funding to one or more universities. This was not viable, because the additional money would then have been distributed internally via the normal governance structures, which themselves were preventing the universities from accumulating and allocating resources for changing in new directions. The other alternative was to exploit the intended RCN Centres of Excellence programme (SFF), which issued its first Call for Proposals in February 2001. The SFF programme was to provide annual funding per centre of around one quarter of that given to Simula, required co-financing from the universities and was essentially bottom-up in character: there was no thematic limitation on applications and centres were chosen based on scientific quality. Waiting for the SFF programme to start would therefore not have allowed Simula to have a capacity-building character, would not have addressed the need for an effort specifically in ICT Fornebu and would not have involved a viable funding model for a functionally free-standing institute.

4. Performance

Representatives of all three Departments of State that fund Simula told us that they were satisfied with its performance and judged it to provide good value for money.

Simula has been subject to two (essentially scientific) evaluations: in 2004 and in 2009. The 2004 evaluation[8] expressed satisfaction with the progress and development of Simula, recognising that it takes time to build up a research group of international standing. It found that the Scientific Computing department was "excellent"; the Software Engineering department was "very good"; and the Networks group was "good, with some very good elements". It recommended that Simula should

- Increase its visibility through increased publication
- Make the strategy less conservative, extending it beyond 5 years and concentrating on likely changes of focus

[8] Maryin Berzins, Bertil Gustafsson, Seif Haridi, Peter F Linington and Colette Roland, *Evaluation of the Simula Research Laboratory*, Report of the Evaluation Committee Investigation, Oslo: Research Council of Norway, 2004

- Raise its postgraduate student targets and seek funding to allow this to happen
- Reconstitute the Board so that it has at least two more people with industrial backgrounds in addition to the chair
- In the eventuality that the Fornebu science part was not revitalised, consider moving geographically closer to UiO
- Be funded for a further five years
- Be placed on a rolling 5+5 year funding basis, subject to evaluation at the 5 year point (which the owners agreed to do)

The 2009 scientific evaluation[9] found that the quality of the research at Simula had improved overall. Scientific Computing was still "excellent"; Software Engineering was now also "excellent"; Networks was now rated "very good" and a number of the projects in the department were "excellent". Publication rates had improved. Postgraduate numbers had increased and were approaching a limit where further expansion risked putting Simula's research mission in jeopardy. The target number of PhD students should therefore remain at 45. The committee recommended continuing funding on the 5+5 year basis and that the real value of the core funding be restored to its original level.

The 2009 scientific evaluation, however, also expressed concerns.

- The original leadership model was stretched to the limit, so that fragmentation of some departments' work was undermining the earlier tight focus of the institute. A new management model was needed
- Simula's strategy was inward-looking and "somewhat static". Simula needed to take a longer-term view, developing a more dynamic strategy of renewal
- Simula's international links had increased, but the committee was concerned that it did not participate to a greater extent in the Framework Programme
- Simula should pursue its desire to acquire academic titles for some of its staff through the use of Professor II (adjunct professor) positions

[9] Torsten Braun, Jan S Hesthaven, Håkan Håkansson and Colette Roland, *Report of the 2009 Scientific Evaluation Committee* (mimeo), Oslo: RCN, 2009

- Simula should extend its relationships in Norway beyond its close links to UiO to encompass other universities

The concept evaluation team additionally notes that the recommendation of the 2004 evaluation to increase the number of people on the Board from industry has not been implemented.

5. Strengths and Weaknesses of Simula

Since this report aims to evaluate Simula **as a concept**, in this section we first consider the advantages and disadvantages of the concept in principle. We then consider which of these advantages and disadvantages Simula has realised in practice, as part of a wider discussion of Simula's strengths and weaknesses.

Advantages

Setting up Simula as a limited company outside a university had several advantages

- It was free to pursue a more flexible and dynamic human resource policy than was possible at the universities. Simula could 'head-hunt' key personnel, by-passing the normal process of university hiring that at the time involved at least a year's delay and possibly more. This mean that Simula could make and deliver offers with a speed that made it internationally competitive in the market for high-quality academic labour. Simula could also fire people in the same way as a company could. Given Norwegian labour law, the degree of employee protection is high by international comparison, but company employers' freedom to hire and fire remains considerably greater than that of the universities
- It was not limited to university pay scales. In fact, Simula has consistently paid about 10% more than UiO for senior staff, making its offers more attractive on the international labour market (on which, it should be remembered, high income and consumption tax rates as well as the high cost of living generally makes Norway less attractive)

- It could offer dedicated research posts, free on the one hand from the teaching obligations of university jobs and, on the other, from the demanding sales requirements that the applied institutes in Norway need to impose upon their senior staff
- It offered incoming research group leaders a high level of resources and considerable freedom in how to use them to develop focused research groups with critical mass
- Its independence meant that Simula could take higher risks than is possible in a university and could develop future-orientated strategies
- It was not controlled by existing university interests, and was therefore free to set its own trajectory independently of university strategies
- The company style of management put Simula in a position to obtain a challenging Board and demanding international scientific advice, rather than be limited by university governance structures

Realising these advantages

Simula has successfully turned most of the advantages we list into strengths. It has indeed used its freedom in Human Resource policy and the lack of compulsory non-research activities to attract international high performers. The leadership has taken risks and built critical mass in the research departments, unhindered by wider institutional concerns. Simula has established a strong record in research and publications. It has established international scientific networks and is admirably international in the composition both of the research staff and among the doctorands, even if the top layer of management is wholly Norwegian.

However, in our view the potential to acquire a challenging but supportive Board of Directors able to help Simula develop a dynamic strategy has not been realised – probably because the Board has only limited industrial and disciplinary experience. Nor is there evidence that Simula has found the kind of scientific sparring-partner it needs in the scientific committee, which is overly Norwegian in its composition and in some cases has disciplinary skills that are too far away from the interests of Simula.

The main disadvantage suffered by Simula was the need to locate at Fornebu. The physical distance from UiO is a clear disadvantage. Even if the distance is small, it is enough to eliminate casual, rather than planned, interaction. However, had the IT-Fornebu venture been successful, it is reasonable to suppose that the advantages of contact with strong industry R&D would have tended to counterbalance this disadvantage.

Weaknesses

Simula's current weaknesses are therefore

- Its strategy, which is inward looking, focusing on Simula's initial agendas, and lacks sufficient long term vision about how the institute will develop and renew itself
- Lack of engagement in the European Framework Programme, which denies Simula both important R&D networks and access to the important focusing or signalling effect provided by the mix of industrial and research interests, especially in IST
- More broadly, lack of high-level, challenging industrial R&D problems and end-user contact that provides strategic intelligence and helps focus even quite fundamental research, where this is intended to have practical use
- Overly comfortable funding, resulting in a lack of 'hunger', as evidenced for example by limited engagement in the Framework
- A top management that is wholly Norwegian, and which therefore lacks the stimulus of deep international roots
- An over-stretched management model. Simula is now at a size where it needs strengthened 'professional' management, separate from the scientific leadership, within the departments
- Physical isolation from both the research community and from 'customers'
- Inward focus
- A legacy of the partisan behaviour of members of the Board in the early days in the form of a current Board that is not optimally equipped to support the further development of the institute
- A scientific advice function that appears insufficiently demanding to provide the intellectual support needed

- The high proportion of foreign doctorands implies a risk that an unacceptably high proportion of them will leave Norway
- Still lagging behind target in doctorand recruitment and struggling to recruit MSc's

Strictly, Simula's commercialisation activities are falling behind target, but we question the wisdom and realism of setting targets for this activity, given the nature and purpose of Simula, the existence of competent private research institutes where commercialisation is one of the main targets and the existence of SFI's (centres for research-based innovation) established in cooperation with industry with clear commercialisation objectives. In addition, commercialisation is always unpredictable and where success tends to require a portfolio and a good deal of luck.

6. What next for Simula?

Time has passed since Simula was conceived. The IT-Fornebu project has had limited success, so the pressure to locate Simula at Fornebu has largely disappeared. Had IT-Fornebu not existed, the logical location for Simula would have been physically near to but organisationally separate from UiO, in order to obtain the benefits of easy interaction with the University while avoiding the disadvantage of being a part of its organisation. That logic still operates today, and since Simula will shortly be in a position to leave the premises it occupies at Fornebu, it should now move to a location physically close to UiO.

We agree with the judgement by KD that Simula could not have survived within UiO, if it had been established there in 2001. Indeed, the senior faculty members from UiO who met us had reached the same conclusion. In the intervening period, the University has started to allow centres of excellence to exist for limited periods of time (up to 10 years, at present) on the campus and is beginning to build the capacity to maintain cross-group project-based organisations and the administrative and governance 'infrastructure' needed to support them. Research in the Informatics Department has been reorganised and currently there is an effort to restructure education. This development process is not complete, but UiO does appear to be taking major steps in a modernising direction. In our judgement, therefore, as Simula reaches maturity (having built and developed critical mass, a strong reputation and a

strategy for continuing and evolving its research activities into the future) the benefits of merging it as a free-standing institute into the University of Oslo outweigh the risks. It will then be easier for Simula to evolve its strategies with the larger context of the University. This does not imply that – at this stage at least – we have seen evidence that system-changing, radical initiatives like Simula can safely be **launched** within the University system. The need for external change agency persists, though it is not clear that the combination of Strategic University Projects and Centres of Excellence (SFF) and Centres for Research-based Innovation (SFI) offered by RCN are able to tackle situations where – as with Simula – it is useful to develop new areas at significant scale.

In considering Simula as a 'concept', we implicitly rely on a view about the role of the universities in the knowledge system and the way in which they change their strategies over time that we should here make explicit.

For good reasons, our society wants advances in science to be well grounded, repeatable and intellectually defensible. University governance is typically conservative, often because of its close relationship to the hierarchical, conservative, quality-focused nature of scientific governance that enables us to depend upon science and to prefer its way of understanding things to less reliable and less well quality-assured belief systems such as magic, tradition or subservience to political authority. The universities are institutional guardians of knowledge. In this social role, it matters not only that the quality of the knowledge is high but also that it includes the **right** knowledge – in the sense that it is knowledge that society values[10]. The universities themselves are at times capable of changing strategic direction, building new kinds of knowledge. At other times, the forces of scientific or institutional conservatism make this difficult and it is useful for the system to experience the kind of external shock that Simula represents. Such shocks may indeed need to be located outside the universities, as was the case with Simula.

However, in the longer term, knowledge evolves but the universities need to maintain their role as guardians of knowledge. Just as the universities survive periods of 'revolutionary

[10] This may be 'applied', cultural, 'fundamental', unpopular, humanities, subversive …

science'[11] when a new orthodoxy replaces an old one, so they should survive the generation of new institutional change agents. Thus, once new sets of knowledge such as those represented by Simula become mature enough to survive within the bigger university system for whatever will be their natural life, then – in the absence of any pressing reason why they should remain outside – their natural home is within the universities, where they should be able to develop, cross-fertilise with other fields and become embedded in education as well as research.

We would expect the extent to which external change agencies are needed to decline over time, as university governance modernises in Norway and the universities are able to develop knowledge strategies that respond better to social needs, while still of course retaining their academic independence. But where, as with Simula, external impetus **is** needed, we would expect to see a process of maturation in the new activity followed by 'renormalisation' or (in another terminology) 'mainstreaming' of the new fields in the university system[12]. Correspondingly, as the fields pursued by Simula become mature and self-sustaining within the Norwegian system, it is natural for Simula to be absorbed back into the university system (from which its leaders initially came) – especially if in the meantime that university system has become tolerant of strong research groups with their own strategies, critical mass and external relationships.

Simula operates (more or less) in what Stokes called 'Pasteur's Quadrant', which is to say that it does fundamental research with the intention that its results will be put to social as well as to scientific use (Figure 1). The connection with the user is not automatic but arises through an understanding of what is likely to be useful. Some of this understanding can of course be acquired through interaction with other researchers working in Pasteur's Quadrant. But in our view a sustainable understanding of potential use requires more direct contact with the world of use. Simula's ambition of acquiring SFI funding from RCN is an important step towards this, as is its contact with key members of the very small 'club' of research-performing Norwegian companies, notably Statoil-Hydro and TeleNor. Systematic

[11] TS Kuhn, *The Structure of Scientific Revolutions*, 2nd ed. Chicago University Press: 1970

[12] For certain applied fields, it would be possible to construct a similar argument for 'renormalising' externally-driven new developments into the applied research institutes, in cases where they themselves were unable to take the initiative for significant change

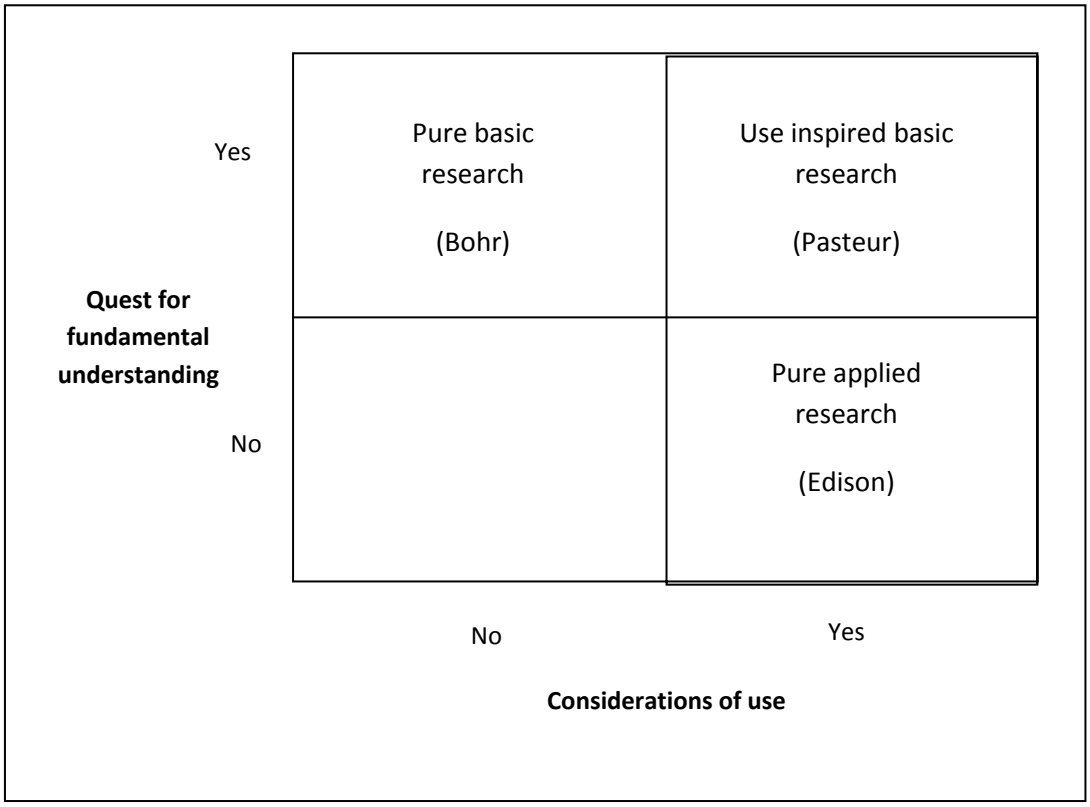
contact with the world of use provides key signals or 'focusing devices'[13]. In our view, Simula has too little access to such focusing devices for three reasons

- The limited number of relevant, research-capable industrial partners in Norwegian industry
- Lack of funding incentives to build such relationships
- Failure to look abroad in order to access such relationships and focusing devices

It follows that Simula's future governance and funding should encourage it to seek a growing proportion of industrial income – not that this should become dominant, but it should be more important than it is today. For this purpose, it may be sufficient to continue KD's policy of maintaining the level of funding for Simula in current but not in real money, so that the effect of inflation is gradually to induce Simula to seek more external funding. However, not only for the sake of the money but also especially for the sake of the industrial contact, Simula needs to work increasingly with highly competent international companies from Europe and the USA in order to maintain its 'edge'.

[13] The term was coined by Nathan Rosenberg in Perspectives on Technology, Cambridge University Press, 1976, and has been applied to the more specific case of industry-university contact acting as a way to focus research attention on fields and problems of industrial interest in Erik Arnold, Barbara Good and Henrik Segerpalm, *Effects of Research on Swedish Mobile Telephone Developments: The GSM Story*, VA 2008:04, Stockholm: VINNOVA, 2008

Figure 1 Sources of Research Inspiration



Source: Donald Stokes, *Pasteur's Quadrant: Basic Science and Technological Innovation*, Washington DC: The Brookings Institution, 1997

Under the current ownership arrangement, NR and SINTEF each own 10% of the shares in Simula. They appear neither to derive benefit from this shareholding nor to add to Simula's development, so the shareholding is mostly a source of frustration, irritation and potential misunderstanding. Our discussions with NR and SINTEF suggested that the main incentive for them to retain their shares is the hope of a potential windfall, enhanced research opportunities, development of new areas of cooperation and economical profit through commercialisations at some stage. KD should therefore buy out these shares, using a simple valuation technique[14] that provides NR and SINTEF with a modest return on investment but not a windfall.

In our view, the governance and management of Simula need overhaul.

- The scientific committee should become entirely international, more challenging and should meet more frequently than at present. We suggest annually. The Scientific

[14] For example, shareholders' funds divided by the number of shares in circulation

Advisory Board is needed to act as a quality control and 'sparring partner' – challenging Simula and its strategy and brining a global view of challenges and opportunities in Simula's fields

- In the early years, members of the Board are said to have tended to represent their organisations' interests rather than focus on developing Simula. As a result, we were told that the current Board in practice comprises people suggested to KD (the majority owner) by the Simula management. While the people involved are evidently committed to Simula's best interests, this is nonetheless bad practice. The role of the Board is to supervise and challenge the management, especially in relation to strategy development. We saw little evidence of this and it was not clear that the Board contained the right skill mix to put Simula's strategy in question. These issues should be addressed as members come up for renewal
- The management structure of Simula is over-stretched. Simula is now at a size where it needs strengthened 'professional' management, separate from the scientific leadership, within the departments

Based on these considerations, we recommend that

- Simula be required to review its management and propose a new structure to its Board and KD within 12 months
- A new Scientific Advisory Board be appointed in short order, comprising only leading foreign scientists from the fields in which Simula operates
- Simula be required to review its scientific strategy to achieve renewal without loss of focus and agree the new strategy with the new Scientific Advisory Board and then its Board. The strategy is to include a demonstration of closer relationships to industry (including foreign industry) and how Simula will participate in the EU Framework Programme
- State funding of Simula should continue at the planned level for the next five years, but the 5+5 model should be discontinued. The money should flow directly from the ministries to Simula, not via RCN or UiO
- KD should continue to be the owner and should buy out the shares of the two minority owners NR and SINTEF at a fair price that does not provide windfall profits

- Simula should use the opportunity provided by the expiry of its lease at Fornebu to move close to UiO
- The owner(s) of Simula should carefully review and assign new members to Simula's Board of Directors, with a mandate to implement the two 2009 evaluation committees' recommendations.
- Simula should remain fully independent of other organisations for the next 3 years. This should be followed by an evaluation of the quality and relevance of Simula. Continuing the current level of funding should be dependent upon
  - Maintaining or increasing the current high level of scientific quality
  - Increasing Simula's contacts and cooperation with industry, while retaining a fundamental focus to the bulk of the Simula's research
  - Developing a plausible and more dynamic scientific strategy
  - Developing a system of governance that allows Simula satisfactorily to function as a free standing research center owned by UiO
- Simula should then transition to become a free standing but internal research centre within (and owned by) UiO across the following 2 years. This should not entail any reduction in funding for Simula or UiO over and above any reduction that may be recommended by the evaluation

7. The Simula Concept

We were very struck by the sour note of many comments about Simula from other actors in the Norwegian ICT research community. Many were envious of Simula's large budget and some objected to the fact that Simula was allowed, in addition, to compete for money from RCN programmes, arguing that Simula's generous funding base stacked the odds against other competitors. Simula was seen as an unfair interruption to the normal process of distributing funding among the members of the relevant research community. This view of research funding as 'distribution policy' (*fordelingspolitikk*) is symptomatic of the problems of lock-in that have historically impeded renewal and change, giving rise to the need for external impulses such as Simula. This is one of a number of rigidities in the Norwegian and many other national research funding systems that make it unduly prone to lock-in. The RCN evaluation argued that funds spent tended to be over-earmarked, limiting the

opportunities for strategic development of the research system. (A well-known example of this was the need to go outside the system in order to launch a functional genomics programme – FUGE – some time after other countries had already done so.) A result of that evaluation was the creation of the Large Programmes division of RCN. Intended to act as an arena for experimentation and as a strategic change agent, the government recently decided to earmark the division's budget, once again eliminating a source of development and innovation in the funding system. The rigidities of university governance have historically been a further source of lock-in, though these appear now to be reducing. Concepts like Simula, with the potential to break lock-ins, are therefore especially important in Norway.

In common with other R&D founders internationally, RCN has developed a repertoire of instruments intended to support strategic change in the universities, the development of critical mass and linkages between research and societal and industrial needs. However, the instrument that supports strategic change is very small scale, while the centre of excellence instruments fund research groups that are already established. There is no routinely-used instrument that can tackle the need to develop capacity at a significant scale, based on fragile beginnings – as was the case with Simula. As the European Research Area progresses, with its increasing drive towards supporting critical mass and promoting specialisation and division of labour within the European research fabric, the need for national level strategic funding instruments to build and strengthen critical masses of excellent research capability will increase further. Small countries, especially, face hard choices about where to specialise and what areas to de-emphasise. The Norwegian funding system needs to think hard about how to decide which areas to emphasise in funding. This cannot only be decided bottom up – not even Norway is rich enough to do that. And it needs to devise instruments that enable significant strategic changes and the building of new capacities, as Simula did. The combination of SUPs, SFFs and SFIs is powerful – but without the presence of capacity-building and **dis**-equilibrating instruments, they comprise a recipe for lock-in. In an ideal world, the universities would take these kinds if new investments and strategies into their own hands. While university modernisation is making this increasingly possible, we are very sceptical of the idea that the university system in Norway and other European countries is yet ripe to do this without external impulses and funding. New instruments are therefore needed that (a) support universities in making significant strategic investments in new fields

and new capacities and (b) provide dis-equilibrating impulses external to the universities, where the university system is unable itself to make the necessary strategic moves. The Simula model is a good example of category (b).

The Simula concept is of course costly, both in research budget and in the amount of time and effort needed to develop and implement it. It needs therefore to be used sparingly, where there is a need to build capacity in focused fields of research and alternative, more routine mechanisms are not available or are unlikely to achieve the desired effect. This is likely to be the case if the change in strategic direction is large and/or the needed research community is small and at an early stage of development. It may also be the case where a new infrastructure is needed that is to be shared widely across research-performing institutions[15].

The use of a Simula-like model need not be restricted to Departments of State. It would be equally appropriate for groups of research performers or others to set up such an institute. Logically, those who 'own' the problem to be solved by the institute should also own it. Thus, if the state judges that there is a need for a new research direction that cannot be met by existing institutions, then a Department of State should own the institute. If the problem to be solved is 'owned' jointly by the universities, then they should be the owner. The exception is RCN, which should not own research-performing organisations, as this would create conflict between its funding role and its ownership role. The use of the model should be triggered by a problem analysis and the willingness of one or more actors to establish and manage the required organisation. This is not an instrument that can or should be

[15] There was dissension in the concept evaluation committee on how the state should fund the start-up and ensuing basic activities of instruments such as Simula. One member of the committee (Dr. Suzanne Lacasse) differed with the others and suggested that when dis-equilibrating instruments such as Simula are to be implemented, the funding should come through a separate increase in the state research budget and not through a reallocation of either funds from other programmes or funds otherwise allocated to universities and research institutes. The reasons for this "need for additional funding for a novel initiative" are rooted in the urgent existing needs for university research funding and the low level of state funding of research institutes in Norway. Based on the interviews done and experience with the Norwegian research infrastructure, Dr. Lacasse believes that establishing Simula had negative effects on the research and opportunities of the research groups already working within ICT in Norway.

implemented by an abstract ‘they’. It is one to which ‘we’ must be committed and where there has to be a project champion willing to implement the project. In so far as such initiatives are dis-equilibrating, they cannot democratically be decided by those involved. Established research communities rarely vote for change. The problem owners must therefore pay, or must find a way to ensure that payment is made.

Simula has shown that the Limited Company form is well suited to this task. It has also highlighted the need for the principles of good corporate governance to be understood and respected. Context matters. Individual situations have to be judged on their individual merits. But as a general principle, there should be a process of ‘renormalisation’ after some years, where the new organisation is absorbed into the permanent structures of the knowledge infrastructure.

Appendix A: Mandate for the Concept Evaluation

Simula Research Laboratory AS (Simula) was established in 2001 as a limited company with the Norwegian Government as the principal shareholder. The company is a not-for-profit, public utility enterprise. The company's objects are to engage in basic long-term research in selected areas of software and communications technology and, by so doing, to contribute to revitalisation and innovation in business and industry.

The objective of this evaluation is to give the Research Council of Norway an impartial and complete report on the activity at Simula. The evaluation will be used as a basis for determining the future funding, status and organization of the centre.

The evaluation of Simula has been split into two parts:

3. **The Scientific Evaluation**: An evaluation of the quality of the research conducted in the center
4. **The Concept Evaluation**: An evaluation of Simula as a new concept in the Norwegian R&D system

In order to define the boundary between the two evaluations, the mandate for the Scientific Evaluation is concentrated towards scientific issues and the scientific leadership at Simula. These issues are general in the sense that they are approximately the same for all research departments or research groups. In general, they are independent of how the department or group is organized, and usually independent of whether or not the department or group is a part of a larger research organization. Issues of relevance that do not belong in this setting shall be addressed in the Concept Evaluation.

The rest of this document specifies the mandate for the Concept Evaluation.

The Research Council's interest is in trying to answer the following questions:

- What are the strong and weak points of the Simula concept?
- What is the added value of Simula type centres for the R&D system in Norway?
- What challenges do Simula type centres represent for the R&D system in Norway?
- To what degree is the results achieved by Simula dependent on the way it is organized?
- Is the Simula concept an interesting model to use in other parts of the Norwegian R&D system?

The Concept Evaluation is not expected to answer all these questions. However, the Research Council expects the evaluation to provide a satisfactory basis for qualified further discussion in the Research Council and relevant government ministries.

The findings of the Concept Evaluation should be presented in a written report. The evaluation should address the following issues:

- Simula's place in the Norwegian R&D system including its roles
    - vs. the universities with regard to research, education, etc.
    - with regard to industrial research
    - with regard to commercialization
- The organization and ownership of Simula including aspects of governance
- The role of the government ministries and the Research Council of Norway
- The development of Simula from its birth until today compared to the original plans for the establishment of the centre
- The funding of the centre (both government funding and funding from industry)
- The lifetime of such centres (indefinite, time limited or based on a rolling 5+5 year contractual basis)
- The added value of "Simula type centres" for the R&D system in Norway
- The consequences of establishing more "Simula type centres" for other parts of the R&D system in Norway
- The location of Simula with regard to the campus of the University of Oslo and other R&D centres in the Oslo region

The Concept Evaluation should be based on:

- A description of Simula
- A self evaluation from Simula
- The original plans for the establishment of Simula
- Relevant parts from government white papers and budget propositions
- Relevant documents from the Norwegian parliament
- The evaluation report from the Simula evaluation in 2004
- The evaluation report from the Scientific Evaluation of Simula in 2009
- Annual reports and other relevant documents from Simula
- Interviews of relevant persons at Simula and its Board, at the universities, in the institute sector, at the relevant ministries and in the Research Council
- A short description of the Norwegian Centres of Excellence and Centres for Research-based Innovation programs (as examples of similar centres of excellence in the Norwegian R&D system)

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Design cover: Design et cetera AS
Photo/illustration: PhotoDisc
Printing: Allkopi
Number of copies: 300

Oslo, May 2010

ISBN 978-82-12-02796-1 (print)
ISBN 978-82-12-02797-8 (pdf)