simula strategy

2018 - 2028

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Preface

How can we improve? That is what this document is about. Simula Research Laboratory was established in 2001 and has since been through a series of evaluations. The results have steadily improved and in the 2017 evaluation, the committee found that all three research areas at Simula were excellent, according to a rigorous definition provided by the Research Council of Norway.[1] It is tempting to think that all is well, and that we should simply continue on our path.

But that is the sound of decline. An ambitious research lab has to reach higher, dig deeper and never be content. So, what can we improve? Almost everything. We produce high quality papers at a good rate, but we can do much better; no one has yet been able to publish in Nature or Science or similar venues. We supervise master students, PhD students and post docs at a fine rate. But we can provide much better supervision for students and post docs; talk to anyone for more than five minutes and you will learn that there is plenty of room for improvements. Furthermore, we have established 16 start-up companies and though most of them, if not all, are doing well, none are doing exceptionally well; and we have yet to sell a company to make a significant profit from our investment.

So, we have to improve every aspect of what we do. But how? That was the question we asked all our employees when we spent one full day of walking and talking in the woods around Østmarksetra in September 2017. In groups of about ten employees, lead by a PhD student or a post doc, our employees discussed the main questions concerning Simula. And they responded with a whole catalogue of suggestions and views which in turn were presented, by the leaders of the ten-person groups, at a seminar for Simula's board of directors. Finally, a group of employees wrote condensed introductions to each strategy issue, and also formulated our strategy for every topic in just one sentence. These sentences are our new strategy.

It remains to be seen if this is the best strategy we have created at Simula, but I know for sure that it has been the most entertaining and enlightening strategy process we have ever had. The strong commitment to our mission and the intensity of the arguments bodes exceptionally well for our future.

Professor Aslak Tveito
CEO, Simula Research Laboratory
February 2018

1. The definition of "excellent", as used by the Research Council of Norway, is found on page 25.

This is Simula

Simula's vision is to be an excellent research lab, solving important and fundamental problems of science and engineering, training highly-qualified experts and leaders, and developing commercial enterprises.

Mission

- Simula conducts research with long-term impact within the fields of communication systems, scientific computing, software engineering, machine learning and cyber security.

- A strong focus on basic research is combined with the teaching of postgraduate students and the development of commercial applications.

Organisation

- Established in 2001, Simula has been headed by Professor Aslak Tveito since 2002 and combines academic traditions with recognised business management models.

- Simula is organised as a limited company owned by the Norwegian Ministry of Education and Research.

- Simula Research Laboratory holds ownership in Simula Innovation (100%), the Simula School of Research and Innovation (56%), Simula@UiB (51%) and Simula@OsloMet (51%), in addition to ownership in 16 companies managed by Simula Innovation.

Production

- Simula's scientific impact as measured through citations: the WoS-indexed publications obtain a citation index of 139[2], which means that the articles have been cited 39 % more than the field normalised world average.

- From 2001 through 2017, Simula's researchers have supervised 114 PhD and 387 MSc degrees to completion in collaboration with the University of Oslo and other academic partners.

Financing

- Simula receives basic allowances from the Norwegian Ministry of Education and Research, the Ministry of Trade and Industry, and the Ministry of Transport and Communications. These financial contributions are imperative and provide the degree of strategic freedom necessary for Simula to perform its unique role in the Norwegian research environment.

- Simula's income profile consists of three approximately equal parts: 1. basic allowance and long term funding, 2. grants awarded by the Research Council of Norway, and 3. income from the EU, industry or other activities.

2. Source: Bibliometric analysis of Simula Research Laboratory by Research Professor Dag W. Aksnes at the Nordic Institute for Studies in Innovation, Research and Education (NIFU), 2016.

Summary

This document lays out Simula's strategy for the ten-year period from 2018 to 2028, and reflects on the practical, structural and philosophical considerations that may impact Simula's future. These considerations are listed below, each with a one-sentence summary of Simula's strategy moving forward.

Vision
Simula's vision is to be an excellent research lab, solving important and fundamental problems of science and engineering, training highly-qualified experts and leaders, and developing commercial enterprises.

Independence and collaboration
Simula will remain an independent research organization while strengthening its current collaborations and seeking new, mutually beneficial partnerships that are in line with Simula's vision.

Research
Simula's research groups will continue to perform important and exciting research, maintain their status as excellent[3] and secure long-term research funding.

Communication systems
The communication systems research area will combine long-term research on fundamental questions with present-day relevance.

Scientific computing
The scientific computing research area will push the forefront of its core expertise, and actively incorporate machine learning to expand the capabilities of computational methods.

Software engineering
The software engineering research area will continue to conduct industry-relevant research, and actively foster sound collaborations with industry and other research organizations.

Machine learning
Simula will expand and further develop machine learning expertise by strengthening the link between theory and algorithms, and between algorithms and high-impact applications that are of particular relevance to society.

Cyber security
Simula@UiB aims to become an excellent research group in the field of cyber security and cryptography, educating highly-qualified IT security experts for the benefit of Norwegian society.

Education
Simula will strengthen its educational framework by demanding excellent supervision of MSc and PhD students, providing a portfolio of courses, and collaborating with regional schools.

Leading Simula
Simula will actively train new leaders at every level, especially at the top of the organization to ensure that well-qualified candidates are available at all times.

Gender equality and diversity
Simula will continue to fine-tune working conditions to best support its diverse workforce, with the goal of increasing the proportion of female employees to 40% within the next 10 years.

Location
Simula will find premises within a reasonable price range that facilitate easy collaboration within Simula and with national partners and, most importantly, provide optimal working conditions for the employees.

3. The definition of "excellent", as used by the Research Council of Norway, is found on page 25.

Open science

Simula will actively cultivate a mindset and provide training on tools for how to conduct reproducible research and support the free dissemination of research results to the extent that is legally and financially possible.

Applied research

Simula will strengthen the applications of its research and contract research will primarily be organized through Kalkulo or new startups.

Portfolio management

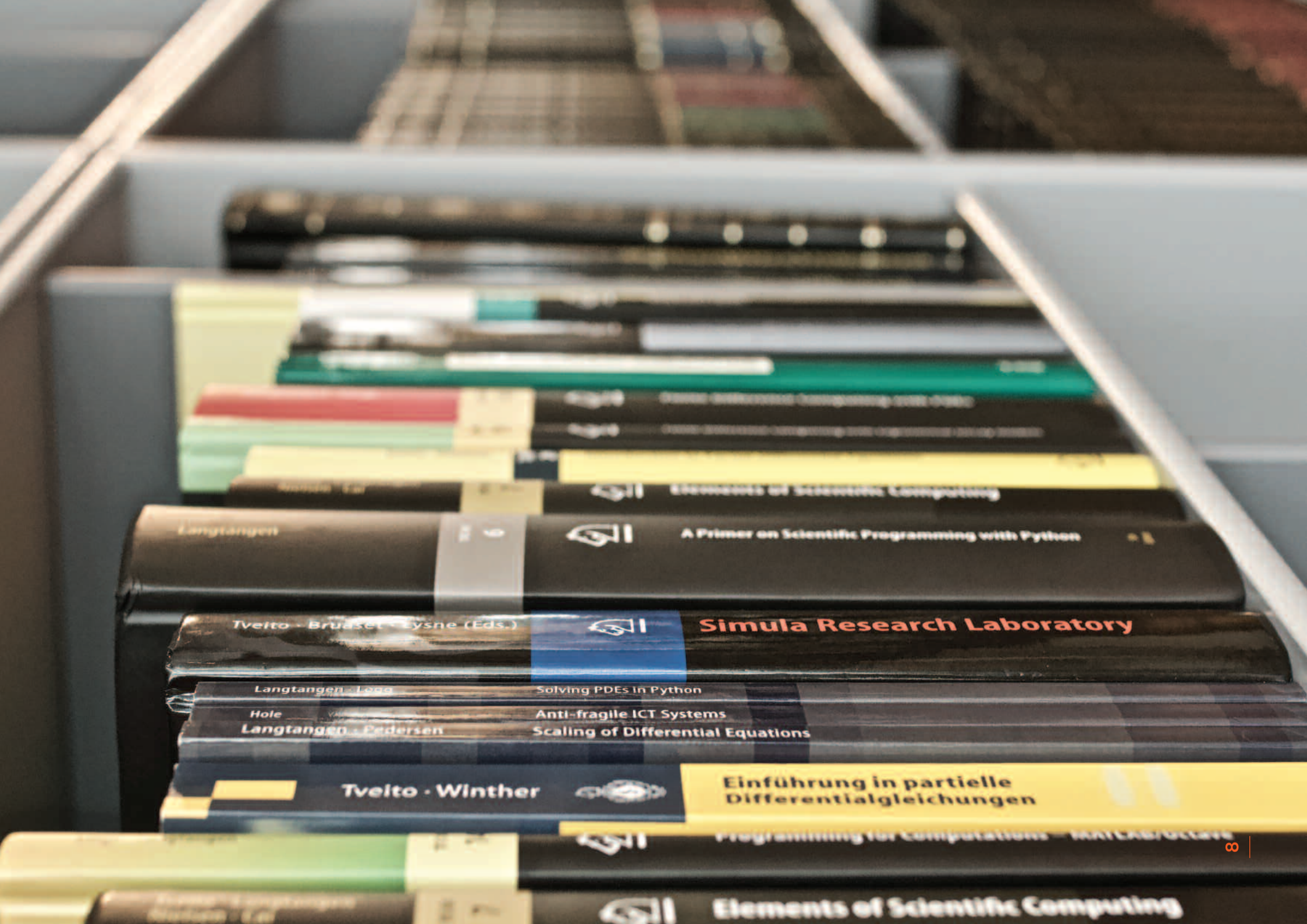
Simula will seek to gain profits from its research activities, with the profits to be reinvested in new commercial enterprises as well as new research and education projects.

Innovation at Simula and the Simula Garage

Simula will promote interactions between Simula researchers and external entrepreneurs, increase technology commercialization efforts, and cultivate the Simula Garage as an attractive incubator for early-stage technology startups.

Articles of association

The articles of association of Simula Research Laboratory will be changed to include education activities, a broader definition of research, and a broader scope for Simula's innovation activities.


A Primer on Scientific Programming with Python
Simula Research Laboratory
Solving PDEs in Python
Anti-fragile ICT Systems
Scaling of Differential Equations
Tveito · Winther
Einführung in partielle Differentialgleichungen
Elements of Scientific Computing

Independence and collaboration

Strategy: Simula will remain an independent research organization while strengthening its current collaborations and seeking new, mutually beneficial partnerships that are in line with Simula's vision.

Simula is a limited company owned by the Norwegian Ministry of Research and Education. A recurring question in various evaluations and public debates has been whether Simula should remain an independent institution. From Simula's perspective, it has been hard to identify compelling arguments for joining other organizations. Simula has extensively utilized its organizational freedom and neither Simula's employees, management, nor board of directors find good reasons to change its organizational foundation. Simula has benefitted significantly from extensive formalized collaborations with selected partners and Simula should continue to pursue such collaborations.

Simula has formal collaborations with three Norwegian institutions of higher education: the University of Oslo (UiO), the University of Bergen (UiB), and Oslo Metropolitan University (OsloMet). The collaboration with UiO is general and comprehensive and includes education, mentoring, research, and formal procedures across most of Simula's scientific topics. The collaborations with UiB and OsloMet are centered on the joint companies Simula@UiB and the Center for Digital Engineering (Simula@OsloMet), respectively. While both companies will include activities within research, education, and innovation, Simula@UiB is dedicated to cybersecurity research, while Simula@OsloMet will focus on the digitalization needs of industry and the public sector. Simula is also in a formal collaboration for joint supervision and mobility with the University of California, San Diego (UCSD) and has recently signed a memorandum of understanding with the Technical University of Berlin that aims to develop an integrative collaboration equal to that with UCSD, centered on communication technology. The evaluation committee was generally very positive about Simula's current collaborations.

Simula will pursue collaborations with a focus on mutually beneficial partnerships that provide the access and expertise it currently lacks. China is investing significantly in future and emerging technologies applied in complex software-intensive systems such as cyberphysical systems, one of the key research areas in software engineering at Simula. A consortium of select Chinese universities and research institutes with well-established ties to Chinese industry could serve as a platform to connect Simula to academia and industry in China. This could give Simula access to largescale real-world case studies, which are necessary for conducting industry-relevant and empirical software engineering research, and Simula could contribute expertise in model-based engineering and empirical software engineering, thus increasing the visibility of the Norwegian research community in China.

The formation of the Einstein Center Digital Future in Berlin is arguably the most forceful investment in digital engineering research in Europe and has the potential for strong synergies with Simula's activities in understanding public infrastructure through empirical research. The center is a collaboration between German industry, the municipality of Berlin, and four universities in Berlin and prioritizes digital infrastructure, methods, and algorithms among its core research areas. Simula gains a clear benefit from collaborating with this center, since the center will provide access to world-class research groups within Simula's core areas and facilitate collaborative work between Simula and German industry.

Research

Strategy: Simula's research groups will continue to perform important and exciting research, maintain their status as excellent and secure long-term research funding.

Research at Simula has changed significantly compared to the previous strategy period. Physically, research at Simula will be distributed over three separate units; in addition to the activities at Fornebu, cyber security research will mainly be conducted at Simula@UiB in Bergen, while the new Center for Digital Engineering established in collaboration with OsloMet will have a broader research agenda, including communication networks, data science, and digitization.

The three research fields that have been present at Simula since the start – communication systems, scientific computing, and software engineering – will continue to be a part of Simula. However, new research areas are being integrated into Simula's research. Thematically, the concentrated effort on cybersecurity was developed during the previous strategy period and is now being singled out as a separate research area within a separate organizational unit (Simula@UiB), with a goal of achieving the rating of excellent. Machine learning has been identified as a new prioritized research area in the upcoming strategy period, and a group will be formed to conduct research and education in machine learning at the research center in collaboration with OsloMet, with a similar aim of excellence. Related and complementary topics will also be developed in other parts of Simula.

Securing collaborations across geographically separate units and across related topics will be a high priority in the coming strategy period. The duplication of work and competences should be avoided and complementary expertise must be utilized for common benefits across Simula. Simula has profited from long-term research funding from the Research Council of Norway for one Centre of Excellence (Center for Biomedical Computing, funded 2007-2017) and two Centres for Research-based Innovation (Certus Centre and Center for Cardiological Innovation, funded 2011-2019). These centers have constituted an important backbone and platform for research activities and research collaboration. Systematic planning and work will be initiated in order to be awarded new long-term research centers to support Simula's research.

Since the competition for research grants is increasing both nationally and internationally, the work with applications must also be increasingly professional and effective. Simula will continuously strive to increase the quality of its work with funding.

Communication systems

Strategy: The communication systems research area will combine long-term research on fundamental questions with present-day relevance.

The research area of communication systems (CS) at Simula was rated excellent in the 2017 evaluation. CS will defend its status by continuing to combine long-term research on fundamental questions with present-day relevance. This means Simula's CS researchers will identify enduring research questions expected to remain relevant for the long term and address them in a way that provides knowledge and technology with short- to medium-term relevance that is closely aligned with emerging societal needs related to CS.

CS research will be conducted within the framework of Simula Research Laboratory, Simula@UiB, and the Center for Digital Engineering, and in collaboration with the highest-performing international partners. Since the three units are located separately, strong collaboration is important. The joint supervision of junior researchers and joint applications for externally funded projects will be part of the strategy to address this challenge. Securing long-term funding that permits long-term research will be of central interest for all units. Furthermore, it will be important to provide opportunities for new scientists to publish in the highest-ranking publication channels. The following topics will be central to Simula's CS research.

Robustness, performance, and controllability of complex communication infrastructures: Simula will utilize its comprehensive measurement infrastructures to build theoretical frameworks and measurement experiments to assess resiliency, performance, and/or fragility on and beyond a single infrastructure for existing and newer technologies (e.g., 5G and IoT).

Anti-fragile systems: Investigations of the cryptographic, information-theoretic, and security aspects of anti-fragile ICT systems will be conducted.

End-to-end performance, reliability, and predictability of latency-sensitive and/or resource intensive multimedia applications: In close collaboration with the high-performance and cloud computing groups at Simula, a comprehensive and cross-layer approach will be applied to assess and ensure the end-to-end performance of new multimedia technologies and applications. Green and robust networks and systems: Simula will contribute to research in cyberphysical systems in the form of network-based solutions with both energy efficiency and robustness as primary goals and will build network and system support for such systems.

Integrative resource management and data-aware workload optimization on heterogeneous cloud infrastructures: Novel approaches spanning transparent application execution, runtime adaptation, proactive reconfiguration, resiliency, automated elasticity, and privacy/security on geographically distributed and federated cloud systems will be investigated.

Scientific computing

Strategy: The scientific computing research area will push the forefront of its core expertise, and actively incorporate machine learning to augment and expand traditional computational methods.

The research area of scientific computing (SC) has developed over the past 15 years, leveraging and building on its successes to reach into new areas of activity. Early on, numerical methods and software were the key activities. Later, targeted, challenging applications gained more attention, including computational biological research and the efficient use of modern large-scale computers. More recently, the field of machine learning (ML) has been gaining momentum and Simula has been successful in obtaining funding to work on infrastructure challenges in future exascale computing. Through these changes, the research at SC has been consistently evaluated as excellent and the group remains committed to being an excellent, world-recognized, scientific computing research environment targeting high-level scientific impact.

The evaluation committee has advised Simula to consider establishing exascale computing as a new research activity in SC, consider alternative models to the current project-based organization, and discuss revenue possibilities (e.g., project funding and obtaining revenue from SC's open-source contributions).

Discussions within Simula revealed that SC should continue to focus on long-term, challenging research in its current and emerging scientific areas, such as ML and exascale computing. The strong potential of ML at Simula is readily recognized. However, building competency is difficult and needs to be well resourced. In order to achieve excellent research in the new scientific activities, a critical mass is required. Therefore, collaboration with ML experts, as well as creating core expertise at Simula through recruiting researchers with drive and momentum should be explored.

Successful proposals are at the core of the financial sustainability of SC at Simula and should continue to be supported through collaborative workshops; strategic initiatives should be proposed when relevant and feasible. Furthermore, SC should explore the potential to create revenue from FEniCS and other software by offering consultancy, tailored solutions, and software integration, perhaps in collaboration with Kalkulo.

There is a desire in SC for a unified vision and to think more collectively. The current project-based organization does not promote communication and collaboration efforts between groups and projects, and thus does not take advantage of potential synergy at Simula. One proposed approach is the introduction of scientific subgroups, such as for theoretical and applied scientific computing, in which strong leaders can be identified.

Software engineering

Strategy: The software engineering research area will continue to conduct industry-relevant research, and actively foster sound collaborations with industry and other research organizations.

The research area of software engineering (SE) at Simula has been consistently evaluated as excellent since 2009. Its main emphasis has been on the validation and verification of software-intensive systems, as well as model-based engineering, software evolution, empirical SE, and search-based SE. Very visible activities in software estimation and planning are also conducted that lean towards the social sciences in terms of research tools and strategies.

Simula's SE group has established strong national and international connections with industry and has been constantly addressing industry-relevant challenges while maintaining highly visible footprints in the academic world. Finally, SE plays an important role in international standardization activities.

Simula's recent evaluation highlighted three key considerations for SE: maintaining a healthy mix of empirical and conceptual activities, defining long-term goals and research priorities, and establishing large-scale strategic collaborations.

Facilitating informal communications among researchers across research disciplines in Simula is considered a tangible solution for fostering internal collaboration and Simula's leaders should play a key role in fostering collaboration across academic borders. National and international collaborations are important for Simula and both deep, long-term collaborations and small, dynamic, project-based collaborations should be encouraged. Collaborations with industry are particularly important for SE to maintain a healthy mix of empirical and conceptual activities and contribute to its own sustainability and growth. A particular opportunity exists to leverage current successful interactions in research and education to establish large-scale strategic collaborations with China, using Simula's experience from establishing the SUURPh program.

Machine learning

Strategy: Simula will expand and further develop machine learning expertise by strengthening the link between theory and algorithms, and between algorithms and high-impact applications that are of particular relevance to society.

Machine learning has gained enormous international momentum. Although not defined as a separate research area at Simula, machine learning and data science were recently identified as important complementary components across research topics at Simula and research activities have been outlined to address the mathematical machinery for machine learning methods.

Moreover, several successful introductory courses on machine learning have been organized as a part of SSRI's activities, including Simula's 2016 Machine Learning Crash Course and the 2017 Massachusetts Institute of Technology–University of Genoa school on Regularization Methods for Machine Learning. These courses have garnered great interest and high attendance.

A new data science strategic initiative will start in 2018 and is expected to address methodology and serve as the 'glue' between applications and projects. The ambition of this initiative is to accumulate sufficient know-how to conduct internationally recognized research. However, it is currently unclear how the initiative can best serve applications and projects and whether it should have more of a consultancy nature or focus primarily on educational aspects and/or joint projects.

The evaluation committee and Simula group discussions have raised concerns about whether Simula can become internationally – or even nationally – competitive without substantial additional support. These concerns appear justified, considering the enormous attention and huge investments in machine learning and artificial intelligence from tech giants and governments.

Through discussions with national and international stakeholders and problem owners, Simula has identified a niche in the Norwegian and European markets where it can play an important role in fundamental research on methods and tools, inspired by applications. These directions have only been developed at several (five, to be exact) large European centers and no activities of this type have been thoroughly addressed yet in Norway.

Cyber security

Strategy: Simula@UiB aims to become an excellent research group in the field of cyber security and cryptography, educating highly qualified IT security experts for the benefit of Norwegian society.

Most of Simula's cyber security and crytography research will take place at the research center Simula@UiB, a limited company jointly owned by the University of Bergen and Simula Research Laboratory. The Norwegian Ministry of Transportation and Communications (Samferdselsdepartementet) partly funds the center. According to a mandate from the ministry, Simula@UiB's primary goal is to increase security expertise in Norway through research and education.

Simula@UiB focuses on two research areas: cryptography and information theory. The cryptography section's goal is to acquire a deep understanding of how to protect sensitive information through the use of mathematical methods. The information theory section focuses on the design and analysis of secure and reliable communications and storage solutions.

The center aims to develop its research activities through research programs that solve security problems of practical interest. Examples of useful projects are Simula@UiB's programs in cryptography and information theory, funded by the Research Council of Norway, that focus on fundamental security challenges in cloud computing.

Simula@UiB is a small research group and must work with external researchers to achieve high-quality research results. The evaluation has recommended that Simula and Simula@UiB work together to create a flow of student and staff exchanges and regular joint activities of shared research interest.

Simula@UiB cooperates with the Department of Informatics at the University of Bergen to provide high-quality education for MSc and PhD students, both via direct supervision and by teaching security courses at the department. Students are actively encouraged to take an introductory security course at the department to improve their understanding of the mathematics needed to complete an MSc in cryptography or information theory.

Simula@UiB arranges international scientific meetings to facilitate research cooperation and will work with commercial and governmental entities to increase the number of MSc and PhD students. Currently, Simula@UiB and Sbanken have agreed to jointly supervise MSc students and Simula@UiB is actively seeking other partners to help supervise MSc and PhD students.

Education

Strategy: Simula will strengthen its educational framework by demanding excellent supervision of MSc and PhD students, providing a portfolio of courses, and collaborating with regional schools.

Education is central to Simula's mission. The Simula School of Research and Innovation (SSRI) has contributed to the education of MSc and PhD students since 2007. In addition to providing a framework for educational activities, SSRI has organized courses, summer schools, and internships and promoted science and technology studies among pupils at regional schools. A total of 387 MSc students and 114 PhD students have completed their degrees under the supervision of Simula personnel from 2001 through 2017.

SSRI will focus on recruitment and supervision and has the capacity to supervise more PhD students if the corresponding funding is secured. The recruitment process should start early. The summer school, internship program, and relationships with the relevant academic institutions are essential ways of establishing connections with MSc students and will be further developed. The supervision will be of high quality and SSRI will develop a reference guide to support both students and supervisors.

Another focus area will be to prepare the PhD students for careers as researchers, scientists, and leaders in academia and industry. A portfolio of courses will be developed and provided on a regular basis.

The Prepare outreach program should be extended in close collaboration with Bærum and other municipalities, with the main goal of finding efficient ways to inspire high school students to pursue higher education within science and technology.

Leading Simula

Strategy: Simula will actively train new leaders at every level, especially at the top of the organization, to ensure that well-qualified candidates are available at all times.

Simula is organized as a limited company. Such a structure is unusual for a research organization and has affected the way Simula has been governed. The Norwegian Ministry of Research and Education appoints the board of directors, who's duties and responsibilities are governed by the law of limited companies (Aksjeloven). Simula's board meets four times a year and handles all significant issues. One important assignment for the board is to hire the managing director.

The present director was hired in 2002 and has no term of office; however, the board can ask the director to leave at any time. The 2017 evaluation committee recommended that Simula discuss how to renew top management. There are no imminent plans to replace the director, but a replacement strategy should be developed. It is common to have terms in academic organizations, with four-year terms seemingly the most common in Norway. Terms are less common, however, among companies and research institutes in Norway.

The requirements for Simula's managing director have changed significantly over the past 15 years. In the beginning, Simula was small and greatly focused on research. Simula has since grown significantly and now carries out comprehensive activities in both education and innovation, a development with consequences for the choice of director. Furthermore, Simula has more or less consistently depended on political support, which is important to maintain for any managing director at Simula.

The board of directors must discuss the requirements for a new leader at Simula: Should a term be introduced? Does the leader need to be a professor? Should the leader be an internal candidate or is it advantageous to seek a new director internationally? Few very strong opinions were presented by the employees, but they seem to lean towards establishing a term for the next director.

Gender equality and diversity

Strategy: Simula will continue to fine-tune working conditions to best support its diverse workforce, with the goal of increasing the proportion of female employees to 40% within the next 10 years.

Since 2010, Simula has followed an action plan to promote gender equality among the scientific staff. During this period, Simula has actively searched for well-qualified female candidates for all scientific and leadership positions. In cases in which the candidates were approximately equally qualified, women were selected. The gender balance has improved over this period to approximately 30% women in scientific positions: the proportion of female researchers has increased from 0% to 22% and the proportion of female PhD students has remained fairly steady, at around 30%. It is worth noting that as of the end of 2017, 28% of all Simula employees were female; this includes engineers and administration, in addition to the scientific staff. Moving forward, we will focus on the proportion of female employees in all of Simula, both scientific and support staff.

Simula's workforce has become increasingly international due to its global recruitment strategy. Talented employees with a variety of cultural and national backgrounds are now part of the Simula environment, 56% of whom are non-Norwegian and represent 30 nations. Simula has matured into a truly multicultural workplace represented by both women and men.

During the strategy period, Simula will increase its focus on gender equality and diversity and further enrich the workplace to fully support a talented workforce. To attract and retain top talent, as well as develop researchers and leaders for the future, it is essential to continue efforts to increase the female proportion of the staff and ensure excellent working conditions to support and enhance the range of experiences, ideas, and creativity provided by such a diverse personnel group.

Location

Strategy: Simula will find premises within a reasonable price range that facilitate easy collaboration within Simula and with national partners and, most importantly, provide optimal working conditions for the employees.

Simula was established as part of the IT Fornebu initiative, a private–public partnership established to use the vast area at Fornebu following the closure of the airport in 1998. The initiative quickly became politically controversial, with limited public and political support.

After a very early evaluation of the project in 2004, the government concluded that Simula should no longer be obliged to be located at Fornebu. This decision had little practical importance at the time, since Simula had a contract to rent its premises until 2010. Close to this deadline, however, a comprehensive process was undertaken to investigate alternatives to Fornebu. Several locations were carefully considered, though rent proved a major difficulty; for example, Blindern was attractive in terms of proximity to the University of Oslo, but the cost was nearly double that of Fornebu. It was therefore concluded that Simula should enter into a new 10-year contract at IT Fornebu.

The present contract ends at the end of 2020. The board has decided that Simula should look for options in the Oslo area. If Simula is to move, a decision should probably be reached in 2018. Simula pays approximately 6 million NOK in rent per year at Fornebu. The price per square meter could be 100% higher around Blindern and downtown Oslo. The current premises are inefficient, however, and Simula could probably use less space in a more modern office building.

Open science

Strategy: Simula will actively cultivate a mindset and provide training on tools for how to conduct reproducible research and support the free dissemination of research results to the extent that is legally and financially possible.

There has been a considerable international drive towards full and systematic transparency in the research process to ensure the quality and correctness of research results and provide more insight into their derivation. In addition, there has been a strong international push towards freely accessible scientific publications through an open-access mechanism, ranging from free self-archiving (green open access) to prepaid journal access (gold open access).

Both open access models have been criticized; prepaid access to journal papers could incentivize publishers to accept substandard submissions, thus diminishing the quality of scientific papers, while self-archiving open access might not be strictly legal in view of the copyrights transferred to the publisher upon publication. Moreover, a paper's preprint has not been through the quality assurance provided by a peer review process.

In the recent evaluation of Simula it was recommended the development of a strategy to become a leader in the drive towards increased repeatability and reproducibility in computational sciences and technologies. The Research Council of Norway encourages the use of open-access journals and requires that all research articles it supports be publically available one way or another.

Although Simula is too small to take a leading role in repeatability and reproducibility in an international context, these concepts are valuable additions to the researcher's toolbox. Several key elements must be considered when selecting a publication venue, with quality and visibility as the primary criteria. Although open-access publishing in high-quality journals would be ideal, the cost of prepaid access is prohibitive on a large scale and open access to all data underlying the research is not possible in some cases due to legal issues, including privacy concerns.

Another possibility for making our research results accessible would involve a more systematic approach to disseminating research software to the community, for instance through open-source repositories. In some cases, access to software could be complemented by open access to curated research data. Such open access to code and data must be considered in the light of potential commercialization and relevant legislation.

Applied research

Strategy: Simula will strengthen the applications of its research and contract research will primarily be organized through Kalkulo or new startups.

Simula specifically targets research topics with the potential for long-term applications and societal value. In an environment that naturally develops basic research into applied value, it is counterproductive to discriminate between basic research and applied research, as this border is often impossible to define.

In cases of results with real application potential, the research activity moves to a commercial venture, either through collaboration with established industrial actors or through spin-offs. In addition to its partial ownership of 15 spin-off companies, Simula owns 100% of the commercial subsidiary Kalkulo. This company was established in 2006 as a direct consequence of research and development collaboration with Hydro (later Statoil). By its very construction, Kalkulo is closely linked to Simula's scientific computing area.

The recent evaluation of Simula suggested that an applied research unit be established and that Kalkulo take on this role, extending its expertise to cover a wider range of Simula's research areas. In subsequent discussions, it became clear that applications are in fact integral components of the research and cannot easily be segregated. For a commercial entity such as Kalkulo to succeed, it should not be limited by organizational constraints that reduce its adaptability to changing markets.

Together, Simula and its spin-off companies provide a unique environment with information and communications technology expertise spanning basic research via applications to commercial implementations. To take advantage of this opportunity, Simula will facilitate internal collaborations and increase the visibility of all relevant facets of the organization for external stakeholders. Organizational support should be developed that minimizes the overhead to implement projects across different organizational units and spin-offs, since this would increase the competitiveness of research projects and commercial opportunities alike.

Portfolio management

Strategy: Simula will seek to gain profits from its research activities, with the profits to be reinvested in new commercial enterprises as well as new research and education projects.

Innovation has always been a part of Simula's mission, with a main focus on the establishment of new companies. In the beginning, this process was very slow. More recently, however, activity has increased considerably in the companies in which Simula is a shareholder. At present, Simula is a shareholder in 16 commercial companies (see the table below), with a total of 103 employees[4]. The total revenue of the companies was 75 million NOK in 2016 and was estimated at 115 million NOK in 2017.

Over the past five years, Simula has consistently worked to develop new companies from its research groups and the Simula Garage. The aim has been to professionalize the very early phase of these companies and focus on their growth and sales to secure their sustainable operation. This strategy has yielded good results and should be continued. However, many of the companies are now fairly mature and Simula had to decide whether to remain a major owner in these companies or sell parts of the portfolio to have funds available for new investments and improved funding for research and education.

The daily operations as an owner of so many companies require resources and Simula will therefore aim to sell its shares of mature companies rather than increase the administration required to run them. In addition, Simula will explore the possibility of licensing valuable software and thereby retain the developers as part of its staff. Finally, Simula Innovation AS (SI) is primarily an investment company and its name will be updated to reflect this core activity and to avoid confusion with the innovation activities currently organized as part of Simula Research Laboratory and the Simula Garage.

Company	Founded	Ownership
Quine	2017	12.5%
Memoscale	2017	4.8%
EYR Medical	2016	8.0%
ecFeed	2016	30.0%
Imerso	2014	12.5%
ForzaSys	2014	30.0%
Fabriscale Technologies	2014	45.0%
Expert Analytics	2013	15.0%
Edgefolio	2013	10.2%
Truegroups	2013	3.5%
Celerway Communications	2012	60.0%
Intelliview	2012	20.0%
Radytek	2012	33.3%
Testify	2010	30.0%
UpWave	2006	5.0%
Kalkulo	2006	100.0%

4. As of June 2017.

Innovation at Simula and the Simula Garage

Strategy: Simula will promote interactions between Simula researchers and external entrepreneurs, increase technology commercialization efforts, and cultivate the Simula Garage as an attractive incubator for early-stage technology startups.

Innovation is a key activity at Simula and in its research focus on solving important societal and scientific challenges. It is important to maintain Simula's high level of innovation in the upcoming strategy period while refining the approach to commercialization to reflect changes in the organization.

Simula-wide commercialization:

The establishment of new research centers together with the University of Bergen (Simula@UiB) and Oslo Metropolitan University (Simula@OsloMet), as well as its collaborations with the University of California, San Diego and the Technical University of Berlin, mean Simula must refine its commercialization activities to best support researchers across the Simula Group. Simula has found a viable model to spin out and develop profitable companies and this approach will be implemented across the diverse units of Simula. A Simula-wide unit will be established to support innovation and increase commercialization activities, with the goal of establishing more spin-out companies and generating revenue through sales and licenses. Access to Simula's technology will be enabled through the establishment of a technology portfolio that will be used to engage with external entrepreneurs.

The Simula Garage (Gründergarasjen):

Since the Simula Garage started in 2013, more than 100 companies and projects, with close to 300 entrepreneurs, have been members. As noted by the evaluation committee (2017), "The Garage has been a successful experiment and should be continued as it provides many benefits to Simula Research Laboratory." In 2018, Simula and OsloMet will establish a separate branch of the Simula Garage, GG@OsloMet, in downtown Oslo. The Simula Garage will continue to refine its services, establish GG@OsloMet as a new innovation hub in downtown Oslo, and facilitate closer interactions between entrepreneurs at the Garage and researchers at Simula and OsloMet.

Articles of association

Strategy: The articles of association of Simula Research Laboratory will be changed to include education activities, a broader definition of research, and a broader scope for Simula's innovation activities.

Paragraph 3 of Simula's current articles of association (Vedtekter) states,

The company is an idealistic enterprise for the benefit of the public. The company's objective is to conduct basic long-term research in select areas of software and communication technology, thereby contributing to innovation in the business sector.

(Official text in Norwegian: *Selskapet er et ideelt og allmennyttig foretak. Selskapet skal ha som formål å drive grunnleggende langsiktig forskning på utvalgte områder innen programvare- og kommunikasjonsteknologi, og gjennom dette bidra til nyskapning og innovasjon i næringslivet.*)

These articles of association were written upon Simula's establishment and no longer accurately reflect the company's current activities. Education activities, applied research, and a broad scope of innovation activities should be reflected in the articles of association.

The following statement was developed by Simula's employees and will be considered an amendment to the articles of association:

The company is a non-profit enterprise for the benefit of the public. The company's objective is to conduct basic and applied research and provide education in select areas of information and communications technology (ICT), thereby contributing to innovation in society.

(Possible new text in Norwegian: *Selskapet er et ideelt og allmennyttig foretak. Selskapet skal ha som formål å drive grunnleggende og anvendt forskning og utdanning innen utvalgte områder innen informasjon og kommunikasjonsteknologi (IKT), og gjennom dette bidra til innovasjon for samfunnet.*)

Definition of "excellent"

In this strategy document, the word "excellent" refers to the specific scientific quality rating that is described by the Research Council of Norway (RCN) as:

Internationally front position, undertaking original research, publishing in the best international journals, and presenting research at recognized international conferences with peer review. High productivity. Very positive overall impression of the research group.

The RCN assembles panels of international experts to evaluate research groups at Universities, Research Institutes, University Hospitals and University Colleges throughout Norway. These subject-specific evaluations are conducted at regular intervals and result in an overall rating of the research groups from 1 (weak) to 5 (excellent). Simula Research Laboratory was evaluated during 2016 and 2017 to give the RCN and the Ministry of Education an impartial and complete report on the activities undertaken at Simula.

Of the approximately 720 research groups in Norway that have been evaluated since 2006, 7% have received the rating "excellent". As of the most recent evaluation, all three research groups at Simula are rated as excellent and comprise 50% of the six "excellent" ICT groups in all of Norway.

Questions guiding the RCN research group evaluations:

- Do the research groups maintain a high scientific quality judged by the significance of contribution to their field, prominence of the leader and team members, scientific impact of their research?
- Is the productivity, e.g. number of scientific and professional publications and PhD theses awarded, reasonable in terms of the resources available?
- Do they show the ability to work effectively with professionals from other disciplines, and to apply their knowledge to solve multifaceted problems?

Scientific quality ratings as defined by the RCN:

1 – Weak
Research quality is below good standards and the publication profile is meagre. Only occasional international publication or presentations. No original research and little relevance to problem solving. Not an overall positive impression by evaluators.

2 – Fair
The quality of research is acceptable, but international profile is modest. Much routine work. Relevance and productivity of research is modest. No original contributions to the field of research. Overall impression is positive but with a distinct degree of scepticism from the evaluators.

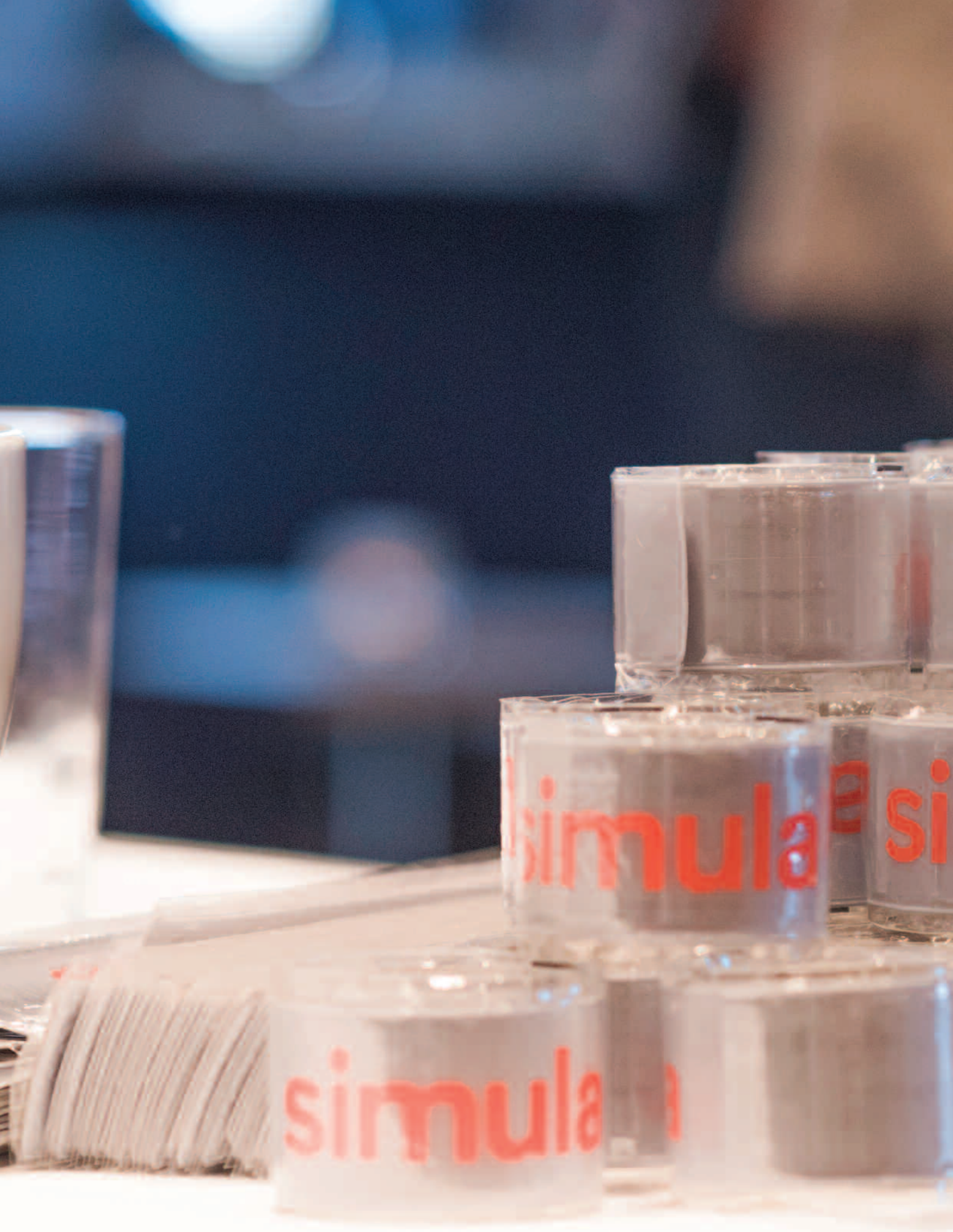
3 – Good - This is the standard expected from a research group in its field.
Contribute to international and national research with good quality research of relevance to international research development. Acceptable productivity. Positive overall impression of research group. The group performs to the standard normally to be expected from a group in its field.

4 - Very good
High degree of originality, a publication profile with a high degree of international publications in good journals and at recognised international conferences. High productivity and very relevant to the field internationally. Very positive overall impression of the research group.

5 – Excellent
International front position, undertaking original research and publishing in the best international journals and presenting research at recognised international conferences with peer review. High productivity. Very positive overall impression of the research group.

Abbreviations

CBC	Centre for Biomedical Computing
CCI	Centre for Cardiological Innovation
CDE	Centre for Digital Engineering
EU	European Union
HiOA	Høyskolen i Oslo og Akershus (English: Oslo and Akershus University College of Applied Sciences)
HPC	High-Performance Computing
ICT	Information and Communications Technology
IT	Information Technology
Lab	Companies in the Simula Group
MSc	Master of Science
OsloMet	Oslo Metropolitan University (in Norwegian: OsloMet – storbyuniversitetet)
PhD	Doctor of Philosophy
RCN	Research Council of Norway
Simula	Refers Simula Research Laboratory and its subsidiary companies (SSRI, SI, Kalkulo, Simula@UiB, CDE).
SRL	Simula Research Laboratory
SSRI	Simula School of Research and Innovation
SI	Simula Innovation
UiB	University of Bergen
UiO	University of Oslo



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