

To the Ministry of Education and Research

SIMULA GRADUATE SCHOOL OF COMPUTING

A proposal from Simula Research Laboratory
for an educational collaboration with UiO and UCSD

15 December 2010



Contents

Til Statsråd Tora Aasland	iii
To Minister Tora Aasland	v
Letter of Support	ix
Facts about Simula Research Laboratory	xvii
Common abbreviations	xviii
1 Simula's initiative in view of Norwegian educational policies	1
We need relevant education of high quality, as well as employees with international knowledge and experience	1
The Ministry's strategies encourage close academic collaboration with the United States	3
The Norwegian Government wants to increase the number of graduates within science and technology	4
Norwegian students show increased preference for the United States as their country of study	6
Summary	8
2 Excellence in research as a platform for international collaboration	9
Simula has continued to consistently achieve a high level of quality research output	9
UCSD can accelerate the quality and impact of research and education in science and technology at Simula and UiO	11
Collaboration with UCSD and Simula can support UiO's goal of becoming an internationally leading university	14
Summary	15
3 An educational program uniting Simula, UCSD, and UiO	16
A directed educational program provides a vehicle for educating leading knowledge workers for the future	16
The bachelor's education lays the platform for advanced studies	17
The master's level education is an integral part of research education	19
Joint research at Simula and UCSD fosters new researchers	20
This education creates future leaders in the global knowledge society	21
Sharing of knowledge and experience requires exchange of people	22

	The existing collaboration between Simula and UiO supports the proposed program	23
	Summary	24
4	Migrating research results from the laboratory to everyday life	25
	Simula is located next door to the largest knowledge-based companies in Norway	25
	A partnership with UCSD will strengthen our power of innovation	26
	Collaboration with UCSD provides experience and operational tools for innovation and entrepreneurship	28
	Summary	29
5	Simula provides the framework for a strong international collaboration	30
	Effective management is required to unleash the power of collaboration	30
	The Simula Graduate School of Computing is the next step in the educational alliance between UiO and Simula	31
	UNIS can serve as an operational model for the Simula Graduate School of Computing	34
	Summary	35
6	The financial implications of the proposed educational alliance	36
	Graduate students can be recruited from tailored bachelor's programs at UiO	36
	The joint master's program requires 14 million NOK of annual funding	37
	The joint PhD program requires 25 million NOK of new annual funding	38
	The principle of free education implies that students at the Simula school should not be charged tuition fees	39
	The proposed program should be implemented in two steps	40
	Summary	41
A	The process of identifying a potential university partner	42
	1 A short list of 10 candidates for collaboration	42
	2 Visits at five of the candidates	43
	3 Continued dialog with UCSD and CMU	44
	4 UCSD as the chosen partner	44
B	Dialogue with stakeholders	45
	1 Strategy seminar of June 11, 2010	45
	2 Discussions of the proposal at board meetings	46
	3 Discussions of the proposal with UiO	46
	4 Dialog with other stakeholders	47
C	Overview of quotes translated from Norwegian	48
	References	52

Til Statsråd Tora Aasland

Regjeringen ønsker å styrke internasjonaliseringen av høyere utdanning¹, den ønsker å styrke forskningen innen IT², og Norges Forskningsråd ønsker å internasjonalisere forskningen i større grad³. Simula ønsker å bidra til dette ved å etablere et utdanningsløp fra bachelor til PhD-nivå som fører frem til doble eller felles grader i samarbeid med Universitetet i Oslo (UiO) og University of California San Diego (UCSD). Programmet vil representere et tilbud av meget høy kvalitet for norske og internasjonale studenter. Studentene vil møte de fremste forskerne i verden innenfor sine fagområder, og programmet vil bidra til kraftig utbygging av forskningssamarbeidet mellom Simula, UCSD og UiO. Programmet er helt i tråd med Simulas ønske om å styrke sin utdanningsvirksomhet, og det er helt i tråd med strategiene til både UiO og UCSD for å internasjonalisere sin forsknings- og utdanningsaktivitet.

Basert på en omfattende evalueringsprosess har Simula valgt UCSD som amerikansk partner i dette studiesamarbeidet. UCSD er et offentlig universitet med over 27,000 studenter, det er nummer 14 på listen over verdens beste universiteter⁴, og nummer 10 på listen som gjelder Engineering og Computer Science. Utdanningsløpet vil være knyttet til UCSDs *Jacobs School of Engineering* som er rangert som nummer 13 blant 198 kandidater i USA⁵, og deres program innenfor bioengineering rangeres som det beste i landet⁶. UCSD har verdensledende forskningsmiljøer innen alle de tre fagretningene som er representert ved Simula. Dette gir grunnlag for å etablere et utdanningsløp av meget høy kvalitet.

Opprettelsen av dette studiet vil innebære en kraftig styrking av samarbeidet mellom UiO og Simula. I løpet av de siste ti årene er det uteksaminert i overkant av 200 master-studenter og 43 PhD-kandidater i samarbeid mellom UiO og Simula. I perioden 2005–2009 har Simulas årlige produksjon i gjennomsnitt tilsvart 17 og 24 prosent av henholdsvis master- og PhD-produksjonen ved Institutt for informatikk. Innenfor eksisterende programmer ved UiO har Simula-ansatte gitt kurs som i 2009 produserte nærmere 7500 studiepoeng.

Simula foreslår et omfang på 30 studenter per kull i bachelor-programmet, 30 i master-programmet og 20 i PhD-programmet; totalt 210 studenter når studieløpet er i full drift. Studiet vil innebære en kraftig økning av antall norske PhD-studenter

¹Kunnskapsdepartementet, St.mld. nr. 14 (2008–2009), *Internasjonalisering av høyere utdanning*.

²Fornyings-, administrasjons- og kirkedepartementet, St.mld. nr. 17 (2006–2007), *Eit informasjons-samfunn for alle*.

³Norges Forskningsråd, høringsutkast *Grenseløs forskning. Strategi for internasjonalt forskningssamarbeid 2011–2015*.

⁴ShanghaiRanking Consultancy: Academic Ranking of World Universities (ARWU). <http://www.arwu.org>, 2010.

⁵US News: Ranking of US Engineering Schools. <http://rankings.usnews.com/best-graduate-schools/top-engineering-schools/rankings>.

⁶UCSD Receives Top Ranks in Doctoral Programs. <http://ogs.ucsd.edu/nrc-results.html>.

som arbeider med en grad ved amerikanske universiteter; fra 43⁷ i 2010 til 103 når programmet er fullt utbygd. Simula ser gode muligheter for ytterligere styrking av PhD-delen av dette programmet gjennom finansiering fra våre samarbeidspartnere. *Senter for internasjonalisering av høgre utdanning* (SIU) opplyser at det per i dag ikke finnes etablerte samarbeid om fellesgrader mellom amerikanske og norske universiteter, og samarbeidet mellom UCSD, UiO og Simula kan derfor bli det første av denne typen.

Realiseringen av det foreslåtte programmet vil kreve stabil og langsiktig statlig finansiering. I sin fullt utviklede form, vil programmet omfatte 60 PhD-, 60 master- og 90 bachelor-studenter. Vi foreslår å starte med PhD-utdanningen, og deretter legge til masterdelen. Det første steget, som iverksetter PhD-utdanningen på basis av Simulas nåværende forskerutdanning, krever en ny årlig finansiering på 25 MNOK. Det neste trinnet, som legger til utdanning på master-nivå, koster ytterligere 14 MNOK og bringer behovet for årlig finansiering opp til 39 MNOK. Parallelt med utviklingen av PhD og master-programmet, foreslår vi at det etableres et bachelor-program på UiO med 30 studenter i hvert kull.

Arbeidet med denne rapporten ble ledet av Professor Are Magnus Bruaset som leder Simulaskolen. Han fikk god hjelp av Marianne Sundet som er administrativ leder av Simulaskolen, og Åsmund Ødegård, leder av administrasjonen i Simulasenteret. Videre er rapporten lest av alle Simulas ansatte som har kommet med mange innspill. Hele prosjektet er gjennomført i 2010 i nær dialog med Kunnskapsdepartementet. Vi er takknemlige for veldig mange avklaringer fra departementet i løpet av arbeidet med dette prosjektet, og vi er spesielt glade for at Statssekretær Kyrre Lekve deltok på et seminar om dette og uttrykte at "*KD er positive*"; det var et svært motiverende innspill til de som har arbeidet med prosjektet, og for alle våre 120 ansatte.

Simula har holdt UCSD og UiO orientert om utviklingen av dette forslaget, men forslaget er skrevet av, og på vegne av, Simula.

Jeg håper Statsråden kan følge opp den positive holdningen vi har møtt så langt og bidra til at vi kan sette dette programmet i gang; jeg lover deg at det kommer til å bli bra.

Vennlig hilsen

Professor Aslak Tveito
Leder av Simulasenteret

⁷Senter for internasjonalisering av høgre utdanning, *Flere norske studenter vil til USA*, <http://www.siu.no/no/Konferanser-og-publikasjoner/Nyheter-fra-SIU-2010/Flere-norske-studenter-vil-til-USA>.

To Minister Tora Aasland

The Norwegian Government wants to strengthen the international aspect of higher education¹, strengthen research in the area of information technology² and the Research Council of Norway wants to increase the international character of research in Norway³. Simula wants to support internationalization through the establishment of an educational program running from the bachelor's to the PhD level, leading to dual or joint degrees in collaboration with the University of Oslo (UiO) and the University of California San Diego (UCSD). The proposed program will offer education of very high quality to Norwegian and international students. The students will meet researchers who are worldwide leaders within their scientific fields, and the program will contribute substantially to broadening the research collaboration between Simula, UCSD, and UiO. The proposed program is fully aligned with both Simula's desire to strengthen its educational activity and UiO and UCSD's strategies for the internationalization of research and education.

Based on a comprehensive screening of possible candidates, Simula has chosen UCSD as its American partner in this educational collaboration. A public university with more than 27,000 students, UCSD is ranked 14th on the list of the world's best universities,⁴ and 10th on the list for Engineering and Computer Science. The educational program will be affiliated with UCSD's *Jacobs School of Engineering*, ranked 13th of 198 engineering schools in the United States,⁵ with a bioengineering program ranked best in the country.⁶ UCSD houses world-leading research groups in all three research areas represented at Simula. This common foundation allows the establishment of an educational program of very high quality.

Implementation of the proposed program implies considerably strengthening of the collaboration between UiO and Simula. Over the last ten years, more than 200 master's students and 43 PhD students finished their degrees as part of the collaboration between UiO and Simula. During the period 2005–2009, Simula's average annual production accounted for 17 and 24 percent of the master's and PhD degrees awarded in the Department of Informatics, respectively. In addition, Simula employees teach courses in existing programs at UiO. In 2009, such teaching produced close to 7,500 European Credit Transfer and Accumulation System (ECTS) credits.

¹Ministry of Education and Research, Report No. 14 (2008–2009) to the Parliament, *Internasjonalisering av høyere utdanning*.

²Ministry of Government Administration, Reform and Church Affairs, Report No. 17 (2006–2007) to the Parliament, *Eit informasjonssamfunn for alle*.

³The Research Council of Norway, discussion paper, *Grenseløs forskning. Strategi for internasjonalt forskningssamarbeid 2011–2015*.

⁴ShanghaiRanking Consultancy: Academic Ranking of World Universities (ARWU). <http://www.arwu.org>, 2010.

⁵US News: Ranking of US Engineering Schools. <http://rankings.usnews.com/best-graduate-schools/top-engineering-schools/rankings>.

⁶UCSD Receives Top Ranks in Doctoral Programs. <http://ogs.ucsd.edu/nrc-results.html>.

Simula propose a program for 30 students annually at the bachelor's level, 30 at the master's level, and 20 at the PhD level, for a total of 210 students when the program is at peak capacity. The program will substantially increase the number of PhD students with Norwegian support who pursue degrees at American universities, from 43⁷ in 2010 to 103 when the program is fully developed. Simula considers the possibility of attracting additional funding from our industrial collaborators to the PhD component of the program to be promising. The Norwegian Centre for International Cooperation in Higher Education (SIU) states that, as of today, there are no established joint degrees between American and Norwegian universities. Therefore, the collaboration between UCSD, UiO and Simula may become the first of this type.

Realization of the proposed program will require stable, long-term funding from the Government. When running at full capacity, it will house 60 PhD students, 60 master's students, and 90 bachelor's students. We propose starting the implementation at the PhD level and thereafter adding the master's level. The first step, realizing the major part of the PhD program on top of Simula's existing educational activity requires a new annual funding of 25 million NOK. The second step, which adds the master's level education, costs another 14 million NOK, thereby increasing the annual funding requirement to 39 million NOK. In parallel with the development of the master's and PhD programs, we propose that a bachelor's program with 30 study seats annually is established at UiO.

Professor Are Magnus Bruaset, as director of the Simula School of Research and Innovation (SSRI), led the preparation of this report. He received assistance from Marianne Sundet, the administrative manager of the SSRI, and Åsmund Ødegård, the director of administration at Simula. Moreover, all employees at Simula have read the report and contributed their comments and thoughts. The project was conducted in 2010 in close dialog with the Ministry of Education and Research. We acknowledge numerous clarifications from the Ministry in the process, and are particularly grateful that State Secretary Kyrre Lekve participated in a seminar about this initiative and declared that "*KD is positive.*" This statement provided strong motivation for those who worked on the proposal and for all our 120 employees.

Simula has kept UCSD and UiO informed of the development of this proposal, but the proposal is written by and on behalf of Simula.

I hope the Minister can join the positive response we have received so far and contribute to the establishment of this program; I promise you that this endeavor will be successful.

Best regards,

Professor Aslak Tveito
Managing Director, Simula Research Laboratory

⁷Senter for internasjonalisering av høgre utdanning, *Flere norske studenter vil til USA*, <http://www.siu.no/no/Konferanser-og-publikasjoner/Nyheter-fra-SIU-2010/Flere-norske-studenter-vil-til-USA>.

Denne rapporten skrives på engelsk av hensyn til de ansatte ved Simula Research Laboratory hvorav over en tredjedel kommer fra land utenfor Norden, og fordi våre samarbeidspartnere i USA må kunne lese dokumentet. For å gi en fullstendig presentasjon på engelsk har alle sitater fra norske dokumenter blitt oversatt. De originale norske tekstene er samlet i Appendix C på side 48.

This report is authored in English to make it accessible to the employees at Simula, of which more than one third come from outside the Nordic countries. It is also essential that our collaborators in the USA can read the document. To give a complete presentation in English, all citations from documents in Norwegian have been translated. The original Norwegian text segments are included in Appendix C on page 48.

Letter of Support

The following pages contains a facsimile of a letter of support from Marye Anne Fox, Chancellor of UCSD, to Tora Aasland, Minister of Research and Higher Education.

UNIVERSITY OF CALIFORNIA, SAN DIEGO

UCSD

BERKELEY • DAVIS • IRVINE • LOS ANGELES • MERCED • RIVERSIDE • SAN DIEGO • SAN FRANCISCO



SANTA BARBARA • SANTA CRUZ

OFFICE OF THE CHANCELLOR

9500 GILMAN DRIVE # 0005
LA JOLLA, CALIFORNIA 92093-0005
TEL: (858) 534-3135
FAX: (858) 534-6523

December 1, 2010

Norwegian Ministry of Education and Research
Attn: Tora Aasland, Minister of Research and Higher Education
PO Box 8119 Dep,
NO-0032 Oslo
Norway

SUBJECT: Regarding Simula Research Laboratory's Initiative for an Educational Collaboration with UC San Diego

The University of California, San Diego (UC San Diego) and Simula Research Laboratory (Simula) have been actively engaged in discussions regarding the establishment of an educational collaboration between our respective institutions and the University of Oslo. I am writing to express our university's significant support of the proposed collaborations, as I am aware that your Ministry will soon receive a formal proposal from Simula in this respect. First, let me begin by sharing some information about our campus with you.

UC San Diego is one of ten campuses state-wide that comprise the world renowned University of California (UC) system. UC San Diego is dedicated to the advancement of knowledge through excellence in education and research at the undergraduate, graduate, professional school and postdoctoral levels. Though this year marks just the 50th anniversary since our founding in 1960, UC San Diego has established itself as a premier academic and research university. U.S. News & World Report ranks our institution as the 7th best public university in the nation. Academic Ranking of World Universities, conducted by Shanghai Jiao Tong University in China, ranks UC San Diego as the 14th best public research university globally.

In addition to academic excellence, the campus is committed to community engagement, public service and industry partnerships in order to advance the health and well-being of our region, the nation and the world. In 2010, Washington Monthly ranked UC San Diego the best university in the nation for its cutting-edge research that drives economic growth; the upward mobility it provides to people from low-income communities; and for molding the character of tomorrow's leaders. The following are just a few examples of the outreach we provide to the greater community to help students reach their academic potential:

- The Preuss School UCSD, located on the UC San Diego campus, is a charter middle and high school dedicated to providing a rigorous college preparatory education for motivated low-income students who will become the first in their families to graduate

Minister Tora Aasland
12/1/2010
Page 2

from college. The Preuss School was named a 2010 National Blue Ribbon School by the U.S. Department of Education, signifying it as a top school in the nation.

- The Early Academic Outreach Program (EAOP) is one of nine such programs administered by the UC Office of the President to increase the number of low-income and ethnically under-represented students on UC campuses. EAOP represents the largest student-centered initiative in the state. Begun in 1976, UC San Diego's program currently serves more than 3,000 students at 16 schools in San Diego and Imperial Counties.
- ScienceBridge strives to deliver quality experiences for over 200 science professionals, 20 graduate students, 100 undergraduate students, 200 secondary school teachers, and 20,000 secondary school students. The strength of ScienceBridge and its component programs is a direct result of building strong relationships between various UC San Diego entities and partner academic institutions, non-profit foundations, multiple school districts, and local/national funding agencies. Since July 2006, ScienceBridge has raised over \$12.5 million in program funding, as part of a long term initiative to expand science education through linking school classrooms with evolving scientific endeavors at UC San Diego and private sector research and development firms.

Our spirit of innovation is embodied in the motto "*Local Impact. National Influence. Global Reach.*" UC San Diego's Technology Transfer Office (TTO) manages the university's large technology portfolio that includes innovations in biomedicine, bioinformatics, engineering, physical sciences, nanotechnology, clean technology, and several other fields. This portfolio includes over 1,400 active patents and more than 3,000 active cases, of which over 1,800 are available for licensing. The TTO facilitates the transfer of innovations created at the university to industry partners for further development as commercial products and services. Through its activities, the TTO fosters an entrepreneurial climate and economic expansion within the greater UC San Diego community and beyond. At the end of fiscal year 2009-10, there were approximately 375 active license agreements for university technology. One-third of these licenses were with companies designated as small businesses. Of the total active licenses, more than half were with California companies or organizations.

The regional innovation infrastructure and strong culture of collaboration provide the UC San Diego community unique opportunities to work with industry partners, especially on the Torrey Pines Mesa. The Sanford-Burnham Medical Research Institute (SBMRI), CONNECT, and UC San Diego Rady School of Management have recently partnered to create an incubator that assists life science innovators and entrepreneurs at SBMRI and UC San Diego with bringing discoveries to market. Similarly, the recent award of a Department of Education (DOE) grant of over \$1 million for three years to the UC San Diego William J. von Liebig Center for Entrepreneurism and Technology Advancement and the Rady School

Minister Tora Aasland
12/1/2010
Page 3

of Management, in partnership with San Diego State University, is another example of the benefit of local partnerships to the UC San Diego community. The DOE grant will allow university and industry leaders to work to accelerate technology transfer of energy efficient and renewable energy innovations. Our initiation of, and participation in, significant energy conservation and environmental sustainability projects have been recognized by the non-profit organization Sustainable Endowments Institute, which listed UC San Diego as one of the nation's greenest campuses in its 2010 College Sustainability Report Card. Students also benefit from these strong collaborative ties, through a thriving academic internship program, significant research opportunities, and numerous career resources that work to engage students with our local industry partners.

Students visiting from abroad are supported by the services provided by our International Center. The International Students & Programs Office (ISPO) annually serves about 2,400 international students—from more than 80 countries—who are pursuing degree and non-degree programs at UC San Diego. ISPO, one of four offices in the International Center, is dedicated to providing comprehensive advising services, programs, informational resources, and volunteer opportunities that support international students and their families in achieving their academic, professional, and personal goals, as well as serving the University's academic departments and research units in pursuit of their mission. International students, including University of Oslo (UiO) students at UC San Diego through the Simula initiative, may participate in our Friday International Café, International Club, English in Action, I-House Monday lecture series, and all other programs available to UC San Diego students. UC San Diego further commits to make every effort to assist UiO students in securing either on-campus housing or non-University housing off campus.

UC San Diego and Simula are natural partners for developing and strengthening educational collaborations. Simula's research excellence in Scientific Computing, Networks and Distributed Systems, and Software Engineering align very closely with major areas of strength at UC San Diego. Since the founding of the San Diego Supercomputer on campus in 1985, UC San Diego has been recognized as a powerhouse in computational science. Especially relevant to the proposed educational collaboration is the Computational Science, Mathematics and Engineering (CSME) graduate program, whose faculty and courses align very well with expertise at Simula in finite element methods, computational fluid dynamics and high-performance computing. Scientific computing is a major focus in the Department of Mechanical and Aerospace Engineering (ranked 11th in the nation recently by the National Research Council [NRC] of the National Academy of the Sciences), the Department of Bioengineering (ranked 1st in the nation by the NRC), and Scripps Institution of Oceanography (ranked 1st overall). In Networking and Distributed Systems, UC San Diego is headquarters to the California Institute for Telecommunications and Information Technology (Calit2), a unique interdisciplinary research institute with strong ties to industry and partner institutions globally. Calit2 has a special emphasis on wireless communications and the role of technology in society. Last but not least, like Simula, the Computer Science and

Minister Tora Aasland
12/1/2010
Page 4

Engineering Department at UC San Diego has internationally recognized leaders in the field of Software Engineering. It also has outstanding undergraduate and graduate programs (ranked 16th in the U.S. by the NRC).

The scope of research activities and educational programs at UC San Diego that coincide with Simula's mission is broad and interdisciplinary, but most of them are partly or wholly connected with our Jacobs School of Engineering (JSOE), which is the natural home division on campus for this collaboration. JSOE ranks 10th internationally, according to the 2010 Academic Rankings of World Universities. The MOU between Simula and UC San Diego that was executed earlier this year grew out of the research and educational collaborations that have been ongoing between Simula researchers and faculty in the Bioengineering and Computer Science and Engineering Departments since 2002. In addition to the services for international students described above, UC San Diego will support the collaboration through faculty, professional staff and teaching assistant salaries. At the graduate level, MS and PhD students will have access to well-funded research laboratories and world class research facilities, including the high-performance computing resources at San Diego Supercomputer and Calit2.

The collaboration proposed by Simula addresses the scientific fields mentioned above, and will include education at undergraduate and graduate levels. At the bachelor degree level, an educational program is to be developed on the basis of existing programs at UiO. The elective parts of these programs will include courses and project modules designed to make the transition to graduate studies at UC San Diego as seamless as possible. Although the undergraduate studies will lead to a Norwegian degree, these students will spend a period of time at UC San Diego, taking courses that will count towards the degree from UiO and preparing for their continuation as graduate students at both universities. At the master and PhD levels, the students in the collaborative program are expected to divide their time between the Norwegian institutions and our campus commensurate with the specific degree program and the relevant degree requirements.

Simula represents a strong and very attractive partner complementing UC San Diego's strengths and expertise. At UC San Diego, we are eager to explore similar synergies in other scientific fields where Simula is internationally recognized. Likewise, we are eager to expand our existing collaboration in research to higher education. Understanding the interplay between the two, we foresee that the proposed educational collaboration will further strengthen the research achievements of our institutions. Furthermore, we regard this initiative to be well aligned with our philosophy of pursuing opportunities in research and education that are interdisciplinary, innovative, and international.

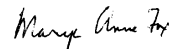
In October 2007, you signed on behalf of the Norwegian government the declaration on educational exchange between our countries. This declaration expresses a desire of continued promotion of "mutual understanding between the peoples of the United States of America

Minister Tora Aasland
12/1/2010
Page 5

and Norway by the exchange of knowledge and professional talents through educational contacts." As stated in the declaration, then U.S. Secretary of State Condoleezza Rice wrote to Norwegian Foreign Minister Jonas Gahr Støre a few months earlier: "There is no better way to cement the people-to-people ties between our countries than through a robust educational exchange program which provides our young people with first-hand experience of each other's culture and strengthens understanding of our shared values."

It is my hope and belief that a collaboration between UC San Diego, Simula, and UiO of the proposed size and significance can become an important step towards fulfilling the ambitions of this declaration.

Kind regards,



Marye Anne Fox
Chancellor

Cc: Managing Director Aslak Tveito, Simula Research Laboratory
Rektor Ole Petter Ottersen, Universitetet i Oslo

Facts about Simula Research Laboratory

Simula is a non-profit, public utility enterprise, organized as a limited company owned by the Norwegian Ministry of Education and Research.

Simula has three main objectives: It carries out basic research at a high international level, explores ways to apply the research work carried out at the center in both industry and the public sector, and educates master's and PhD students and postdoctoral fellows, primarily in cooperation with the University of Oslo.

The laboratory conducts basic research in the fields of communication systems, scientific computing, and software engineering. Complementing the portfolio of research projects, Simula hosts the Center of Biomedical Computing, which is a Centre of Excellence awarded by the Research Council of Norway. The laboratory has also been awarded other prestigious projects by the Research Council of Norway, including two Outstanding Young Researcher grants. The 2009 evaluation, conducted by the Research Council of Norway, concluded that Simula's research is at an internationally high level.

Simula has an annual budget of 115 million NOK (about 19 million USD), of which about 40 percent is funding from the Government. Simula seeks cooperation with industry to provide solutions and increase research relevance.

Simula is proud of its international environment and cultural diversity, employing over 120 unique minds from 23 different countries.

Simula was established in 2001 and is headed by Professor Aslak Tveito.

Some common abbreviations

ANSA	Association of Norwegian Students Abroad
ARWU	Academic Ranking of World Universities
CMU	Carnegie Mellon University
CSE	Computers in Science Education
ECTS	European Credit Transfer and Accumulation System
NTNU	Norwegian University of Science and Technology
PhD	Doctor of Philosophy
SIU	Norwegian Centre for International Cooperation in Higher Education
SRL	Simula Research Laboratory AS
SSRI	Simula School of Research and Innovation AS
UCSD	University of California, San Diego
UiO	University of Oslo

Simula's initiative in view of Norwegian educational policies

The Simula Graduate School of Computing is a proposed educational initiative that meets the challenges and opportunities described in the Government's report on the internationalization of higher education. The combined forces of Simula, UCSD, and UiO can provide a high-quality graduate program that will attract talented and motivated students, nationally and internationally. Policies and current trends regarding mobility and collaboration with the United States bodes well for a joint educational provision of this type.

We need relevant education of high quality, as well as employees with international knowledge and experience

The combination of professional knowledge and cultural experience is highly sought after by society and industry. These skills are necessary in today's global society and therefore also key factors for increased value creation in Norway. Erling Øverland, the former president of the Confederation of Norwegian Enterprise (NHO), summarizes the situation on behalf of the Norwegian industry in the report *Kunnskap og kompetanse*¹:

We need more students in the countries we have much trade with, and where research and development is strong. We need more students pursuing degrees abroad. We need more students abroad within science and technology. We need students with good knowledge of English and skills within communication and outreach.

Complementing this view, the Ministry of Education and Research states in a report² to the Parliament (Storting), "The future value creation assumes global competitiveness. For this we need relevant education of high quality, and we need citizens and employees with international knowledge and experience." This statement affects the strategic and political goals for higher education in Norway, and as a

¹NHO: Horisont 2008. Kunnskap og kompetanse. http://www.nho.no/getfile.php/bilder/RootNY/filer_og_vedlegg1/horisont_1_2008_lav.pdf, page 72. Our translation from Norwegian, see C-1.

²Ministry of Education and Research: Report No. 14 (2008–2009) to the Parliament, *Internasjonalisering av utdanning*. <http://www.regjeringen.no/pages/2152661/PDFS/STM200820090014000DDDPDFS.pdf>, page 5. Our translation from Norwegian, see C-2.

consequence internationalization³ is of high priority. Internationalization of higher education in Norway concerns the individual institutions' strategies and actions to meet the demands and take advantage of the possibilities resulting from globalization. Furthermore, in the Government's report⁴, internationalization relates in particular to the development of the quality and attractiveness of academic efforts:

Internationalization shall be used as a tool to measure up against others and be a response to the challenges posed by globalization processes. Internationalization shall result in higher academic quality and provide greater relevance for pupils and students to meet the challenges of multicultural and internationally oriented businesses and communities. In higher education, internationalization shall be a tool for institutions to develop quality and attractiveness.

The effect of internationalization is of great value for the individual parties involved, including the society and industry that depend on the generated knowledge and the recruitment of the best human resources available. The Government's report⁵ states,

It is also important that in the context of increased internationalization, better links are developed between education and research. On the one hand, it is desirable to ensure greater broadness of recruitment for research, but also the transfer of knowledge and the involvement of master's students especially in research projects can have great significance. Student mobility, where this is seen in close connection with research groups that work tightly together, is believed to be particularly valuable.

As further discussed in Chapter 5, the experiences discussed in the evaluation of the Quality Reform in 2007 argue that even though a lot has been done toward the internationalization of higher education, there is still the potential to achieve better results. In the report⁶, the Ministry discusses the evaluation and points to the importance of securing strong links between courses, faculty members, and management, as well as the need to make sure that internationalization is followed up with strategic priorities from the managements involved.

As argued in the following chapters, the Simula Graduate School of Computing can be an effective instrument for addressing the internationalization challenges and opportunities described. Simula's current proposal promotes the establishment of a high-quality educational program in computing closely integrated with UCSD and

³We understand and use the term *internationalization* as it is clarified in the Ministry of Education and Research: Report No. 14 (2008–2009), page 6.

⁴Ministry of Education and Research: Report No. 14 (2008–2009), page 11. Our translation from Norwegian, see C-3.

⁵Ministry of Education and Research: Report No. 14 (2008–2009), page 63. Our translation from Norwegian, see C-4.

⁶Ministry of Education and Research: Summary in English: Report No. 14 (2008–2009) to the Parliament, Internationalisation of Education in Norway. http://www.regjeringen.no/pages/2255014/PDFS/STM200820090014000EN_PDFS.pdf, page 13.

UiO. The graduate school will lead to dual or joint degrees from UCSD and UiO at the master's and PhD levels. Due to Simula's flexible organization, strong scientific record, and an already established and fruitful research relation with UCSD and UiO, Simula is in an excellent position to initiate this new contribution to the Norwegian educational system.

“Internationalization shall result in higher academic quality and provide greater relevance for pupils and students to meet the challenges of multicultural and internationally oriented businesses and communities.”⁷

The Ministry's strategies encourage close academic collaboration with the United States

Research is an inherently international activity, and a prerequisite for excellent higher education. Most problem areas are oblivious to national borders, and the influence of new research-based insight in society at large is seldom confined to one country: The industry that assimilates results from research searches globally for the best solutions, and the criteria for quality of research are international. In addition, the journals that publish the most important research results have international editorial boards. Because of such characteristics, internationalization has been a priority in Norwegian research policy for many years. This focus is evident in the two latter reports⁸ on research to the Parliament, which clearly convey a strong tradition of collaboration within Europe, and the existence of a well-established set of supporting organizations.

For countries outside of Europe, Norway has developed bilateral agreements concerning research and higher education. A bilateral agreement between the Norwegian and American governments was signed in 2005, building on dedicated collaborations and supporting agreements developed throughout the last 50 years. Concerning higher education, this bilateral agreement was strengthened by the signature of a separate declaration⁹ in 2007, citing correspondence between the then US Secretary of State Condoleezza Rice and the Norwegian Foreign Minister Jonas Gahr Støre:

There is no better way to cement the people-to-people ties between our countries than through a robust educational exchange program which provides

⁷Ministry of Education and Research: Report No. 14 (2008–2009), page 11.

⁸Ministry of Education and Research: Report No. 30 (2008–2009) to the Parliament, Klima for forskning. <http://www.regjeringen.no/pages/2178785/PDFS/STM200820090030000DDDPDFS.pdf>; Ministry of Education and Research: Report No. 20 (2004–2005) to the Parliament, Vilje til forskning. <http://www.regjeringen.no/Rpub/STM/20042005/020/PDFS/STM200420050020000DDDPDFS.pdf>.

⁹Declaration on Educational Exchange between the United States and Norway. http://www.regjeringen.no/upload/KD/Vedlegg/UH/Internasjonalt/Deklarasjon_Nord-Amerika-strategien.pdf.

our young people with first-hand experience of each other's culture and strengthens understanding of our shared values.

The computer industry, both hardware and software, originated from important research institutions in the United States, particularly California. In fact, California is a place where universities and industry interact in a way that fosters innovation as very few other places. Over several decades, US universities and research laboratories have played fundamental roles in science and technology in general, and a dedicated collaboration with a leading US university is therefore highly desirable. This will be further described in Chapter 4.

In the Ministry of Education and Research's *Nord-Amerika strategi for høyere utdanningssamarbeid 2008-2011*¹⁰, academic quality and focus on innovation stand out as strong arguments, among others, for why the United States should be a central collaboration partner and source of knowledge for Norwegian academic environments. To participate and access the knowledge generated in the American academic environment, the Ministry finds it best to further develop and strengthen relations within research and higher education. The current initiative can be an important contribution to the implementation of that policy.

The Government's strategy describes goals related to the creation of more transatlantic collaborations between institutions, and to the stimulation of a substantial increase in the number of students graduating with US degrees or undertaking parts of their education at American universities. To ensure long-term and strong collaborations, relations should be firmly rooted in the institutions' management. Furthermore, a collaboration of this type should include the exchange of faculty and students, a common curriculum, common educational modules and programs, the promotion of aspects related to innovation and entrepreneurship, as well as strong connections between the PhD programs of the involved parties. The Simula Graduate School of Computing will implement these visions with the provision of dual or joint degrees at the master's and PhD levels.

The Norwegian Government wants to increase the number of graduates within science and technology

A main goal for the Norwegian Government is to increase the number of graduates within science and technology. In the preface to the Ministry of Education and

¹⁰Ministry of Education and Research: Kunnskapsdepartementets Nord-Amerika strategi for høyere utdanningssamarbeid 2008–2011. <http://www.regjeringen.no/upload/KD/Vedlegg/UH/Internasjonalt/NA%20Strategi08.pdf>.

¹²There are, in general, two types of mobile students: those who graduate abroad, *mobile degree students*, and those who enjoy a temporary stay abroad as part of their Norwegian degree, *exchange students*.

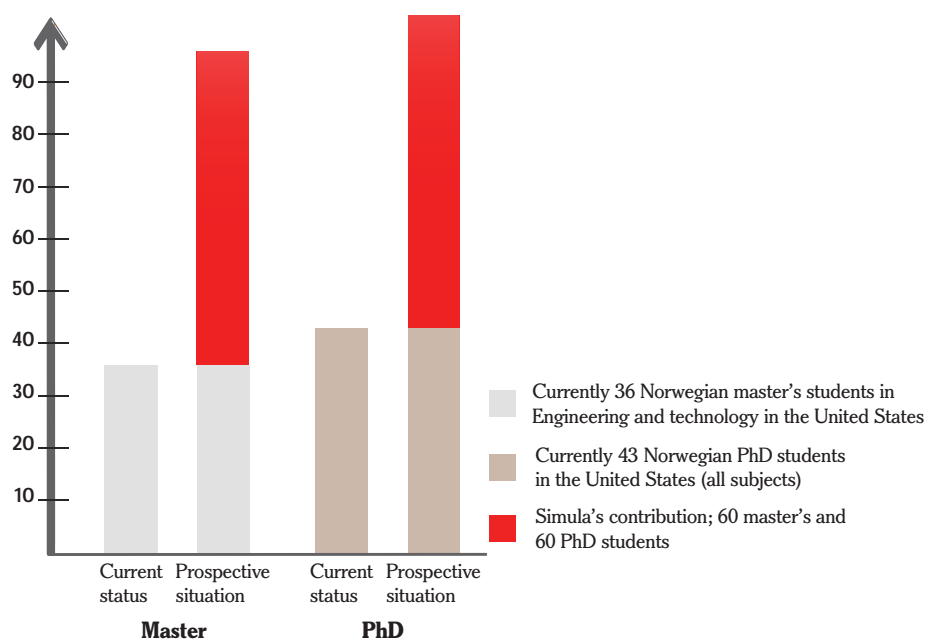


Figure 1.1: This figure shows the relation between the current number of mobile degree¹² master's students in science and technology receiving Norwegian support for studies in the United States, and the corresponding number taking into account the intended capacity of the Simula school. The same relation is illustrated at the PhD level. Since the specific number of PhD students within science and technology is not available, the total number of Norwegian-funded PhD students in the United States across all subjects is used here.

Research's *Strategi for styrking av realfag og teknologi 2010-2014*¹³, the Minister states that "The overall objectives of the initiative are to enhance pupils' and students' competence in science, increase the interest in science, and strengthen the recruitment and progression at all levels..." During 2005–2009, the number of first-priority applications to studies within science increased by 12 percent, while the same number to technology studies increased by 30 percent. Despite this indication of growing interest, the Ministry's strategy report¹⁴ states that "There is nevertheless a long way to go to reach the OECD level, and the Ministry still reckons that recruitment is a great challenge that must be met with sturdy measures in the strategy period."

The Norwegian State Educational Loan Fund reports that in 2010, 36 mobile degree students were funded to undertake master's studies in the United States within science and technology. Prospectively, as seen in Figure 1.1, this number can be more than doubled with the proposed initiative that can host 60 master's students.

¹³Ministry of Education and Research: *Realfag for framtida. Strategi for styrking av realfag og teknologi 2010–2014*. <http://www.regjeringen.no/upload/KD/Realfagstrategi.pdf>, page 5. Our translation from Norwegian, see C-5.

¹⁴Ministry of Education and Research: *Realfag for framtida*, page 21. Our translation from Norwegian, see C-6.

Currently there are 43 students undertaking PhD degrees¹⁵ in the United States who receive funding from the Norwegian State Educational Loan Fund. With its 60 PhD students, the Simula Graduate School of Computing has the potential to more than double the annual output at this level as well.

Norwegian students show increased preference for the United States as their country of study

The Norwegian Centre for International Cooperation in Higher Education (SIU) reported¹⁶ recently that the number of Norwegian-funded students aiming to study in the United States is increasing, a trend that supports the Simula Graduate School of Computing initiative; in fact, the number of students who chose to commence mobile degree studies in the United States this year increased by 10 percent from last year. In a recent press statement¹⁷, Minister Aasland declared,

I consider it positive that the statistics from the last few years show a positive trend when it comes to students taking a full academic degree in the United States, after a decline for several years. The Government hopes that this trend continues.

The Norwegian State Educational Loan Fund reports¹⁸ that in 2009–2010 1013 students were enrolled in US universities, undertaking study programs as mobile degree students, an increase from 913 the previous year. In addition, 1074 students were involved in exchange programs as part of their Norwegian degree program, an increase from 960 the previous year. The Simula Graduate School of Computing will provide a program with dual or joint degrees that combines the properties of mobile degree studies and exchange programs: It provides more international exposure than that obtained in general exchange programs, and it equips the students with both a Norwegian and an American degree. An Association of Norwegian Students Abroad (ANSA) report¹⁹ argues that as a measure to stimulate studies abroad, international combined educations can be fruitful:

¹⁵Numbers for PhD studies within specific subject fields are not available.

¹⁶Higher Education, The Norwegian Centre for International Cooperation in: Nyheter fra SIU. <http://www.siu.no/Konferanser-og-publikasjoner/Nyheter-fra-SIU-2010/Flere-norske-studenter-vil-til-USA>.

¹⁷Ministry of Education and Research: Press release published on the Ministry of Education and Research's website August 26, 2010. <http://www.regjeringen.no/nb/dep/kd/aktuelt/nyheter/2010/flere-studenter-tar-utdanning-i-utlandet.html?id=613014>. Our translation from Norwegian, see C-7.

¹⁸Norwegian State Educational Loan Fund: Utenlandsstatistikk. Flere tar full studiegrad i utlandet. http://www.lanekassen.no/Hovedmeny/Om_Lanekassen/Statistikk/utlandsstatistikk/Flere-tar-full-studiegrad-i-utlandet/Statistikk-utland-2008-2009.

¹⁹ANSA: Tiltak for økt mobilitet og kvalitet. http://www.ansa.no/Om_ANSA/Politikk/Tiltak-for-okt-mobilitet-og-kvalitet. Our translation from Norwegian, see C-8.

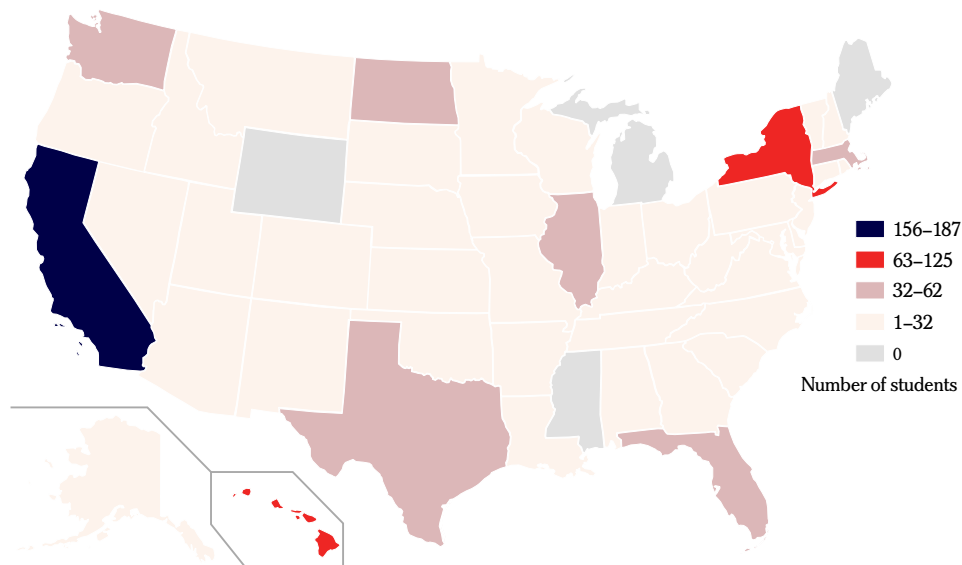


Figure 1.2: This figure shows the distribution in 2010 of Norwegian mobile degree studies in the United States. California stands out as hosting the highest number of Norwegian-funded students. The data were provided by the Norwegian State Educational Loan Fund.

A way to encourage more studies abroad is to facilitate combinations of Norwegian and foreign education where students can study a few years at an institution in Norway and the rest abroad, while maintaining the distinctive professional skills obtained in Norway in the specific subject.

As will be further described in Chapter 3, the time the students will spend abroad in the Simula school program is more extensive than in regular exchange programs, where students tend to spend between six months and one year abroad. While students gain valuable experience from the period abroad, there are general concerns that an exchange period may delay their studies. Since the components of the Simula Graduate School of Computing will be seamlessly combined and totally integrated in each individual student's study track, such delays are minimized.

In addition to academic quality, other motivational factors affect a student's choice of program and institution, and, with a view to student recruitment, it is important to take such factors into consideration. California offers an attractive environment and an array of different and interesting cultural activities. As seen in Figure 1.2, the distribution of the total number of Norwegian-funded students who are currently pursuing full degrees in the United States shows that a substantial portion have already chosen California as their destination.

Summary

Society needs relevant education that is of high quality and gives students international experience. Furthermore, the Government wants to strengthen collaboration with American academic environments. With the described intention, scale, and quality, the joint graduate program will be an attractive study option for national and international students, and provide the encouraged academic collaboration with the United States. At full capacity, annually 20 students will complete their PhD degrees from both UiO and UCSD. The Simula Graduate School of Computing will thus be a significant provider of highly educated people with international experience who are sought after and needed as members of the Norwegian workforce.

Excellence in research as a platform for international collaboration

The scientific strengths of Simula, UCSD, and UiO are presented as the basis for successful international collaboration in terms of research, innovation, and education. This chapter discusses the potential impact that the proposed collaboration will have on research quality, research opportunities, and technology transfer for all partners involved.

Simula has continued to consistently achieve a high level of quality research output

With these words, the 2009 evaluation committee¹ summarized Simula's research achievements over the last five years. In fact, over the last decade, research at Simula has been subject to three scientific evaluations performed by independent panels of internationally recognized experts on the request of the Research Council of Norway. The first report², dated 2001, concerns an evaluation of ICT research in Norwegian universities, including research groups at UiO that became the foundation of Simula the same year. The two later reports³, from 2004 and 2009, specifically discuss Simula's research. All three evaluations document strong research results (see Table 2.1). Seen in sequence, these reports also document a consistent increase in research quality and impact.

In connection with the 2009 evaluation⁴, the committee stated,

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.

¹Braun, T. et al.: Simula Research Laboratory, Scientific Evaluation. 2009, page 16.

²Risch, T. et al.: Research in Information and Communication Technology in Norwegian Universities and Colleges. A Review. The Research Council of Norway, 2002.

³Berzins, M. et al.: Evaluation of the Simula Research Laboratory. The Research Council of Norway, 2004; Braun et al.

⁴Braun et al., page 11.

Research area	2001	2004	2009
Scientific computing	Excellent	Excellent	“Excellent in every aspect”
Software engineering	Good	Very good	Excellent
Communication systems	–	Good	“Very good with some excellent projects”

Table 2.1: The evaluations of Simula’s research results show consistent improvement over time in all three research areas. In 2001, the research department in communication systems was not evaluated as a group. However, based on the evaluation of the relevant group fragments that were later combined to form a department at Simula, it is reasonable to assess this activity as “Good” in 2001.

The committee concluded that Simula’s research in scientific computing is “excellent in every aspect,” while software engineering is seen as excellent and research in communication systems is very good, with some excellent projects.

In the 2009 evaluation report⁵, the committee also commented on Simula’s international research collaboration:

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.

Based on the evaluation committee’s assessment and advice, the design and implementation of dedicated, long-term relationships with internationally leading university partners will be a focal point in our strategy in the following years.

Since its inception in 2001, Simula has had a close and mutually fruitful collaboration with UiO. The educational alliance can be complemented and strengthened by including a leading academic partner in the United States. Ideally, such an academic partner must score high in the following criteria:

Research quality. There should be research groups at the chosen university that consistently make strong contributions to the research community. Ideally, these contributions should be at least as strong as Simula and UiO’s own.

Scientific coverage. As many of Simula’s fields of expertise as possible should find related expertise at the chosen university. This aspect is important because the success of the proposed educational alliance will depend to a considerable extent on the possibility of drawing upon Simula and UiO’s scientific resources.

Educational quality. The chosen university must offer strong undergraduate and graduate programs in areas that are relevant to Simula’s fields of expertise. Moreover, these programs must be research based and take advantage of modern pedagogics, preferably encouraging student projects motivated by real-world applications.

⁵Braun et al., page 14.

Industrial integration. All parts of Norwegian academia should improve their interaction with industry.⁶ Successful cases from the United States can teach best practices to be implemented on the Norwegian side.

Social responsibility. The Norwegian Government aims at developing institutions with a high degree of social responsibility. To establish a long-term educational collaboration, it is therefore necessary to find a partner that actively shares these values.

UCSD can accelerate the quality and impact of research and education in science and technology at Simula and UiO

Since February 2010, Simula has conducted a dedicated search for an educational partner in the United States. This process, documented in Appendix A, has concluded that Simula's preferred partner is UCSD. Our review of UCSD has determined that this university fulfills all of the criteria described above:

Research quality at UCSD. The *Academic Ranking of World Universities*⁷ (ARWU) is compiled by the ShanghaiRanking Consultancy.⁸ In the 2010 ranking, UCSD holds 10th place in Engineering/Technology and Computer Sciences, and 14th place overall.⁹ In the 2010 Times Higher Education (THE) ranking, UCSD is in 32nd place.¹⁰

Scientific coverage at UCSD. The Jacobs School of Engineering, the scientific anchor at UCSD, conducts world-class research within the areas of communication systems, scientific computing, and software engineering applied to biomedical problems. Within the Institute of Geophysics and Planetary Physics and the Scripps Institution of Oceanography, UCSD houses world-leading expertise on geoscience.

Educational quality at UCSD. Collaborative and cross-disciplinary programs stand out as the centerpiece of UCSD's educational provision. The university's high level of recognition is demonstrated by its application and admission statistics. For example, UCSD received more than 47,000 applications for undergraduate programs starting in the fall of 2009; of these, only 3,749 ended up as registered students, leading to an acceptance rate of less than 8 percent. In traditional rankings of colleges based purely on academic parameters, the

⁶Bernander, John G.: Må ha relevante partnere. Debate in Aftenposten, June 9, 2010.

⁷ShanghaiRanking Consultancy: Academic Ranking of World Universities (ARWU). <http://www.arwu.org>, 2010.

⁸The ARWU ranking is viewed by many as the most influential international ranking of academic institutions, see Wildavsky, Ben: *The Great Brain Race. How Global Universities Are Reshaping the World*. Princeton University Press, 2010, page 112.

⁹For comparison, the highest-rated Norwegian university, UiO, is in 75th place overall. There are no Norwegian institutions among the top 100 ARWU listings by field, neither within Engineering/Technology and Computer Sciences nor within Natural Sciences and Mathematics.

¹⁰An error made UiO fall off the THE list in 2010, while in 2009 it held 101st place. In 2010, the University of Bergen was in 135th place.

Jacobs School of Engineering ranks 13th (seventh best public university) among the United States' top engineering schools.¹¹ At the graduate level, the National Research Council ranks UCSD first in the United States in bioengineering, biological sciences, and oceanography and atmospheric sciences.¹² Of these three programs, the first listed is very relevant to Simula's research and education. The university also scores strongly overall, with almost two-thirds of the doctoral programs ranked in the top 20 in their field, and is the second best public university in the United States after University of California, Berkeley.

Industrial integration at UCSD. Located in an area heavily influenced by knowledge-based business, UCSD has a very strong focus on industrial collaboration. In particular, UCSD's Corporate Affiliate Program, research centers, and sponsored research projects involve more than 150 companies (see also Chapter 4). Complementing research collaboration with large companies, the university continuously bears new commercial offspring in terms of start-up companies and technology patents. Bringing innovation, entrepreneurship, and leadership into the classroom, UCSD also houses strong educational programs through the von Liebig Center¹³ and the Gordon Engineering Leadership Center¹⁴.

Social responsibility at UCSD. In August 2010, the renowned political magazine *Washington Monthly* published its new national universities rankings¹⁵, ranking UCSD first of all colleges in the United States. This new ranking is designed to probe "what colleges are doing for the country,"¹⁶ combining traditional parameters of academic quality with a range of measures of social responsibility. One of many such measures is the amount of need-based grants offered by the institution to low-income students, while several others target the institution's and the students' involvement in community services. The chosen methodology¹⁷ leads to a new ranking with a very different perspective¹⁸ on higher education excellence in the United States compared to more traditional methods.

¹¹US News: Ranking of US Engineering Schools. <http://rankings.usnews.com/best-graduate-schools/top-engineering-schools/rankings>.

¹²UCSD Receives Top Ranks in Doctoral Programs. <http://ogs.ucsd.edu/nrc-results.html>.

¹³William J. von Liebig Center. <http://www.vonliebig.ucsd.edu>.

¹⁴Bernard and Sophia Gordon Engineering Leadership Center. <http://www.jacobsschool.ucsd.edu/GordonCenter>.

¹⁵Washington Monthly's 2010 national universities rankings. http://www.washingtonmonthly.com/college_guide/rankings_2010/national_university_rank.php.

¹⁶Washington Monthly Ranks UC San Diego 1st in the Nation for Commitment to Service. <http://ucsdnews.ucsd.edu/newsrel/awards/08-23MonthlyRanks.asp>.

¹⁷A Note on Methodology: 4-year Colleges and Universities. http://www.washingtonmonthly.com/college_guide/feature/a_note_on_methodology_4year_co.php.

¹⁸Introduction: A Different Kind of College Ranking. http://www.washingtonmonthly.com/college_guide/feature/introduction_a_different_kind_2.php.

Facts about UCSD



- Public university
- Founded in 1960
- 27,417 students, of which 4,274 at the graduate level
- Annual revenue: 2.6 billion USD (approximately 15.6 billion NOK)
- Six Nobel Prize laureates and two Fields Medal laureates
- Leading within biomedical research and simulation
- Broad scientific profile
- Well-established research collaboration with Simula since 2002

ARWU 2010–UCSD No. 14

World Rank	Institution*	Region	Regional Rank	Country	Total Score
1	Harvard University	Americas	1		100.0
2	University of California, Berkeley	Americas	2		72.4
3	Stanford University	Americas	3		72.1
4	Massachusetts Institute of Technology (MIT)	Americas	4		71.4
5	University of Cambridge	Europe	1		69.6
6	California Institute of Technology	Americas	5		64.4
7	Princeton University	Americas	6		60.8
8	Columbia University	Americas	7		60.4
9	University of Chicago	Americas	8		57.3
10	University of Oxford	Europe	2		56.4
11	Yale University	Americas	9		54.6
12	Cornell University	Americas	10		52.6
13	University of California, Los Angeles	Americas	11		52.2
14	University of California, San Diego	Americas	12		50.0
15	University of Pennsylvania	Americas	13		49.0
16	University of Washington	Americas	14		48.7
17	University of Wisconsin - Madison	Americas	15		46.4
18	The Johns Hopkins University	Americas	16		46.0

Tight collaboration with UCSD will help sustain and further improve the quality of research at Simula and UiO. This view is also shared by Simula's Scientific Advisory Board, which specifically encourages educational alliances with internationally top-ranked universities. Such a collaboration has the potential of increased ability to attract researchers from the absolute top tier, and will create a unique channel of contact to American academia and industry. The joint graduate program will be an important catalyst for positive synergies in research. Moreover, joint research interests are essential to realizing the full potential of the collaboration. The most effective way of nurturing such joint interests is through funded research projects and the exchange of faculty members. Such incitements could typically consist of PhD scholarships subject to joint applications from researchers located in Oslo and San Diego and financial incitements to sabbaticals.

Facts about UiO

- Public university
- Established 1811
- 27,700 students
- Annual revenue: 5.8 billion NOK
- Four Nobel Prize laureates
- Broad scientific profile
- Well-established research collaboration with Simula since 2001
- Ranked as Norway's leading university in the ARWU



UiO : Universitetet i Oslo

ARWU 2010–UiO No. 75

World Rank	Institution*	Region	Regional Rank	Country	National Rank	Total Score
70	Leiden University	Europe	20		2	28.4
71	Ecole Normale Supérieure - Paris	Europe	21		3	28.3
72	The Hebrew University of Jerusalem	Asia/Pacific	5		1	28.1
72	University of Helsinki	Europe	22		1	28.1
74	Moscow State University	Europe	23		1	27.9
75	Osaka University	Asia/Pacific	6		3	27.7
75	University of Oslo	Europe	24		1	27.7
77	Boston University	Americas	47		44	27.3
78	University of Arizona	Americas	48		45	26.8
79	Stockholm University	Europe	25		3	26.4

Collaboration with UCSD and Simula can support UiO's goal of becoming an internationally leading university

The strategic objective for UiO in 2020, as stated in the strategy document¹⁹, reads, “The University of Oslo will strengthen its international position as a leading research-intensive university through a close interaction across research, education, communication and innovation.” Moreover, UiO expresses a concrete ambition of developing its own organization, educational programs, and research policies in directions that encourage and stimulate international collaboration. Their strategy signals special emphasis on interdisciplinary research and education. Clearly, UiO is determined to excel in its position as the leading Norwegian university to become a strong actor on the international arena. Concerning education, UiO states²⁰ that

Internationalisation of study programmes will be enhanced through increased cooperation with strategic partners and through securing agreements with leading universities. Together with these universities, UiO will establish more and better international programmes, recruit more foreign students and increase the number of international lecturers participating in study programmes.

In addition, the strategy document²¹ makes it clear that “cooperation with foreign institutions will be increased in order to achieve greater relevance and a higher

¹⁹Strategy 2020 University of Oslo. <http://www.uio.no/om/strategi/Strategy2020English.pdf>, page 1.

²⁰UiO Strategy 2020, page 7.

²¹UiO Strategy 2020, page 6.

level of quality.” The proposed collaboration with UCSD and Simula answers these challenges precisely and effectively.

Existing bachelor’s programs at UiO will serve as an excellent foundation for tailored transitions to graduate programs that run collaboratively at UCSD and UiO under the umbrella of the Simula Graduate School of Computing, leading to dual or joint degrees. The proposed collaboration is a natural extension of the current educational provisions through SSRI (see Chapter 5). For both UiO and Simula, the proposed collaboration can potentially nurture unique research opportunities through tight interaction with one of the highest-ranked universities worldwide. Clearly formulating its collaborative profile through the statement, “The University of Oslo shall demonstrate the ability and willingness to transcend boundaries, whether they be academic or national borders,”²² UiO stands out as the obvious Norwegian university partner in the proposed alliance.

Summary

In the 2009 evaluation of Simula, it was pointed out that Simula should strengthen its international collaboration. In particular, the committee stated that the educational unit, SSRI, could become a national resource for science education and take on a role as a coordinating center across several universities involved in research collaborations with Simula. This view is also shared by Simula’s Scientific Advisory Board, which specifically encourages educational alliances with internationally top-ranked universities. Clearly, UCSD fills the role of such a partner excellently.

Recently, UiO published an ambitious strategy aiming at a position as an internationally leading research-based university. The objectives and action points in this strategy encourage and require deep involvement with leading universities worldwide. Within the research fields targeted in this proposal, UCSD can be an ideal candidate partner for UiO.

Joint research interests are a prerequisite for fulfilling the potential of the proposed collaboration. Based on such interests, joint responsibility for the supervision of master’s and PhD students combined with the mechanism of dual or joint degrees will act as a catalyst for positive synergies in research. The funding of joint research projects and the exchange of faculty members are important means of realizing such synergies.

²²UiO Strategy 2020, page 1.

3

An educational program uniting Simula, UCSD, and UiO

The Simula Graduate School of Computing will offer an educational program covering master's and PhD studies. This new educational provision will be based on existing programs at UiO and UCSD, which will be bridged by new courses and other pedagogical components. This chapter discusses the scientific and pedagogical profile of the new program and shows the interfaces to scientific research, innovation, and entrepreneurship initiatives at the partner institutions.

A directed educational program provides a vehicle for educating leading knowledge workers for the future

The main goal of the proposed educational alliance between Simula, UCSD, and UiO is to educate leading knowledge workers for the future, specialized within computing. These individuals are characterized by scientific and technological skills at the highest possible level, an understanding of the societal and commercial values to be derived from such skills, international experiences from living abroad and collaborating closely with faculty and students in a multicultural environment, and high ethical and moral standards in their work and behavior.

The vehicle to reach this goal is a directed educational provision from the undergraduate studies through a finished PhD degree in which state-of-the-art pedagogical tools are used to synthesize all the elements needed. Moreover, it is important that active researchers, capable of motivating and enriching students through a truly research-based education, conduct the teaching, even in the initial stages. In light of the high ambitions for the new educational program, it is crucial that tailored program components at the bachelor's and master's levels support the challenging journey to a finished doctoral degree. In a recent report¹ to the Parliament, the Government states

The possibility of smooth transition from master's to PhD studies have support from several agencies, including the Research Council of Norway and the doctoral students' association at NTNU (DION). Such arrangements have the potential to increase the completion rate in the Norwegian research training, and bring down the average age of completed doctoral degrees.

¹Ministry of Education and Research: Report No. 14 (2008–2009) to the Parliament, Internasjonalisering av utdanning. <http://www.regjeringen.no/pages/2152661/PDFS/STM200820090014000DDDPDFS.pdf>, page 56. Our translation from Norwegian, see C-9.

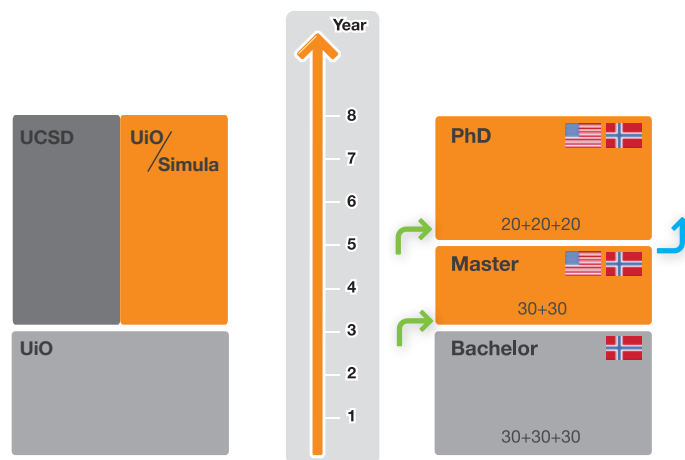


Figure 3.1: This diagram presents the structure of the proposed educational program, covering an eight-year track from the bachelor's to the PhD level. The left-hand element of the diagram indicates that bachelor's programs at UiO are the main recruitment base for graduate studies, while UCSD, UiO and Simula share the responsibility for the master's and PhD levels. In practice, the interfaces between the different institutional roles will take a less regular shape than that pictured here, and may shift over time. The boxes on the right-hand side refer to the three educational levels of bachelor's, master's, and PhD studies. In each box, each given number refers to the number of students in each year. The green arrows indicate that students from other universities or programs may enter certain program components, and the blue arrow shows that students enrolled in a program component at the Simula school may leave.

A well-prepared transition between the different educational components is seen as particularly valuable in the recruitment of students. The proposed program provides intrinsic support of such transitions, between both educational levels and different educational environments.

The bachelor's education lays the platform for advanced studies

The basic foundation of the graduate program in computing will be a three-year bachelor's study. This part will not be taught at the Simula Graduate School of Computing (see Figure 3.1), as suitable programs already exist at UiO. In particular, the two programs presented in Figure 3.2 can provide the necessary basis for continued studies at the Simula school. The elective components in these programs can be tailored for the multi-institutional profile of the school, in order to provide a well-prepared transition from the bachelor's level to graduate studies. Alternatively, the undergraduate provision could be implemented through the creation of a new bachelor's program at UiO, specifically designed to match advanced studies at the Simula school. In both cases, the students will have a clear study path towards graduate studies leading to dual or joint degrees between UiO and UCSD. One

Informatics: Programming and Networks			
6.	elective courses		
5.			
4.	compulsory course		
3.	INF1300	INF2220	INF1060
2.	INF1010	INF1050	EXPHIL03
1.	INF1000	MAT1001	INF1080
Semester	10 credits	10 credits	10 credits

Mathematics, Informatics, and Technology			
6.	elective courses		
5.			
4.			EXPHIL03
3.	MAT1120	STK1110/MEK1100	compulsory course
2.	MAT1110	FYS-MEK1110/STK1100	INF1010
1.	MAT1100	MAT-INF1100	INF1100
Semester	10 credits	10 credits	10 credits

Figure 3.2: UiO's bachelor's program *Informatics: Programming and Networks* (top) can serve as a basis for the Simula school's provisions in the fields of software engineering and communication systems. Likewise, the program *Mathematics, Informatics, and Technology* (bottom) can be the foundation for the school's graduate studies in scientific computing.

specific way to tailor such a bachelor's program would be to implement carefully structured student exchange between UiO and UCSD. In addition to qualifying the students for the joint graduate program, well-designed measures for student mobility can improve the attractiveness of UiO's bachelor's program to prospective students.

The bachelor's education in this program would be the responsibility of UiO, and Simula proposes the allocation of 90 bachelor's level study seats at UiO for this particular purpose, see Chapter 6. Also, an exchange program at the bachelor's level would be the responsibility of UiO. To ensure a well-prepared transition to the graduate studies, Simula would be ready to collaborate with UiO in the specification and implementation of this provision.

The master's level education is an integral part of research education

To become aligned with the American principle of a bachelor's degree being the entry point to a doctoral education, the Simula Graduate School of Computing will offer a two-year master's level component designed to lead smoothly up to a three-year PhD education (see Figure 3.1). However, unlike in most US universities, the students will earn their master's degree with a thesis as a formal and practical stepping stone toward their doctoral status. This requirement will ensure alignment with the Norwegian educational system, and also serve as an educational forking point where students can choose to leave or enter the offered study path. Since there are fewer seats available in the PhD component than in the master's component, there will be a decision gate between these two graduate levels anyway. Seen from the American side, the completion of the master's level component would be similar to passing the course requirements needed before starting the doctoral research project.

Students entering the master's component of the educational program will have to satisfy the admission criteria at both UCSD and UiO. These students are recruited from bachelor's programs at UiO or other relevant undergraduate programs. Students receiving their master's degree from this program will be well trained for continued research education at the Simula Graduate School of Computing or at other institutions in Norway or the United States, or, alternatively, for pursuing a professional career in industry or the public sector.

Students will have to qualify for higher-level studies by taking certain combinations of courses supporting the multi-institutional profile of the educational program. Wherever applicable, the courses will contain project assignments of interdisciplinary nature. This approach is also an effective tool for weaving societal impact, ethics, and important soft skills together with science, technology, and business aspects. At the same time, the students are trained to work in a way that is very similar to the workflows found in industry and the public sector. Thereby, the students who successfully complete this type of education will be very attractive candidates in the job market.

Early exposure to real-life problems boosts motivation for learning. Therefore, the master's students will enter an active area of research as soon as possible, leading up to a master's thesis that will form the basis of continued PhD studies. Whenever possible, master's level work should provide the basis for an international publication, in terms of a journal paper or a contribution to a well-respected conference. Typically, such results will come to fruition as the starting point for the climb toward a doctoral degree.

The choice of a short master's thesis (30 ECTS credits) seems to provide a high degree of compatibility with typical American study programs. In the United States, most PhD students start out from their bachelor's degree and go through four to five semesters of graduate courses before starting their research activities

in full. The well-established option of a short master's thesis at UiO implies more coursework (90 ECTS credits), which then, to a large extent, resembles the American educational structure. One could then consider the completed master's degree to be equivalent to passing one's qualifiers².

During the two years of master's level studies, students will typically spend the first and fourth semesters in Norway, and the second and third semesters at UCSD's main campus. Two experienced researchers, one from UiO or Simula and the other from UCSD, will supervise each master's student.

After successful completion of the master's level education, the students will receive master's degrees from UCSD and UiO, either as dual degrees or as a joint degree. As stated above, the master's degree should be approved for further independent studies in Norway and the United States, as well as for continuation in the PhD program component at the Simula Graduate School of Computing.

Joint research at Simula and UCSD fosters new researchers

Having successfully completed the master's level in the program, or being a strong candidate with relevant background from another institution, one may enter the three-year research education at the Simula Graduate School of Computing as a PhD student³, see Figure 3.1. Since this educational provision is designed to hold fewer seats than the master's component (20 seats compared to 30), only the most skilled and motivated students are given the opportunity to continue from the master's level. Students may also be recruited from other relevant graduate programs. In any case, students entering the PhD component will have to satisfy the admission criteria at both UCSD and UiO.

On average, PhD students will spend approximately half their time in Norway and the remaining half in the United States. After conducting the initial semester in Norway, the actual division of time between Norway and the United States will depend to a certain extent on the student and the student's team of supervisors. However, to allow the design of an efficient infrastructure for the educational program, a certain amount of educational elements should be shared by all PhD students. Supporting all PhD scholarships in the educational program, there must be joint research activity between Norway and the United States. That is, at least two experienced faculty members, one from each country, will supervise each PhD student. As needed, the team of supervisors may be extended to include other relevant competence holders from academia or industry.

²The qualifiers refer to a set of exams based on advanced courses that need to be passed before one receives the official status of being a PhD candidate and is allowed to concentrate on a research topic as a PhD thesis.

³As discussed in the previous section, most American universities see PhD education as a five-year track starting with the bachelor's degree. In connection to the Simula school, the master's level component must then play the role of the initial stage of a US PhD program, which focuses greatly on coursework and qualifying exams.

The PhD students in the program will strive toward a deep specialization. However, the underlying principles of interdisciplinary approaches to solving important problems will remain part of their educational foundation. Therefore, it will often be reasonable to group a suitable number of PhD students to work on closely connected research projects. In the course of study, both the students and the supervisors should regularly revisit their vision of the expected impact of the conducted research in terms of innovation potential and other types of societal benefit. At this educational level, as well as at the bachelor's and master's levels, relevant courses on innovation and entrepreneurship are available through UCSD's von Liebig Center⁴.

After successful completion of the doctoral education, the students will receive PhD degrees from UCSD and UiO, either as dual degrees or as a joint degree.

This education creates future leaders in the global knowledge society

The expected learning outcome of the education offered at the Simula Graduate School of Computing is not only increased scientific insight, but also an improved, experience-based understanding of the chosen topic's value and importance. In fact, the learning process, resulting in professional and personal development, is as vital as the research itself. As discussed in Chapter 1, doctorates coming from such a culture will be in demand by industry and society at large. Such candidates will be future leaders in a knowledge-based society.

Acknowledging that leadership is a craft that needs to be learned, some students may want to complement their scientific training with additional education focusing on business and leadership skills. Focusing on leadership in research and engineering, UCSD's Gordon Engineering Leadership Center⁵ offers relevant educational programs at the undergraduate and graduate levels. Selected courses from these programs can be candidates for courses in the Simula school's educational program. In a larger setting, the interplay between the scientific elements and the focus on innovation and entrepreneurship in the proposed program provides a natural interface to business-related studies outside the Simula school, typically leading to an MBA degree. Such complementary education is relevant for students who have completed their master's or PhD degrees. Over some time, the school may pursue agreements with suitable partners to ease the transition for the students in question. Such agreements could also be of value to other graduate students at UiO and UCSD.

⁴William J. von Liebig Center. <http://www.vonliebig.ucsd.edu>.

⁵Bernard and Sophia Gordon Engineering Leadership Center. <http://www.jacobsschool.ucsd.edu/GordonCenter>.

Sharing of knowledge and experience requires exchange of people

The mutual exchange of knowledge and experience between students and faculty across Simula, UCSD, and UiO is at the heart of the proposed educational program. At the bachelor's level, which is dominated by coursework, this aspect can, to a large degree, be implemented in terms of students at the US campus through an exchange program.

“Work should be done on focusing more attention on mobility for all staff members, both academic and non-academic, through developing methods and tools that make this easier to facilitate.”⁶

At the master's level, and even more so at the PhD level, efficient interaction and close collaboration between faculty members in Oslo and San Diego are crucial. Existing academic alliances at

the US universities listed in Appendix A, and which Simula visited during the partner selection process, show that the requirement of well-functioning faculty-to-faculty connections is imperative. Therefore, in addition to letting students spend time in both environments, faculty members should also spend time at the other location. During such visits, which may last from weeks to semesters, they should teach and conduct research and explicitly interact with the local inhabitants, students and faculty alike.

To ensure that well-established faculty members take on the practical challenges of moving to another location for a semester or longer periods, there is a need for incentives. One important incentive for an established researcher is access to highly qualified project workers, typically in terms of PhD students. Therefore, the scholarships offered in the PhD program should be tied to specific research proposals set forth by supervisors who are geographically separated. Moreover, the funding of a PhD student should be supplemented by a certain allowance that can fund travel and other research-related resources for the supervisors.

In addition to students visiting UCSD from Norway, UiO and the Simula Graduate School of Computing could receive visiting students from other relevant UCSD programs. This possibility has been discussed in recent dialogs with UCSD's administration and there is strong interest in implementing a reciprocal visitor program.

On average, the Simula school will have 60 students visiting the main campus in the United States at any time. In addition, one expects two to three faculty members to visit UCSD at any time. To ensure the smoothest possible exchange of students and faculty, there will be a need for a dedicated service center for the Simula school

⁶Ministry of Education and Research: Summary in English: Report No. 14 (2008–2009) to the Parliament, Internationalisation of Education in Norway. http://www.regjeringen.no/pages/2255014/PDFS/STM200820090014000EN_PDFS.pdf, page 14.

located at UCSD's main campus in San Diego. This center will need to be staffed by two to three administrative positions and manned by additional personnel with experience from both Simula and UCSD. This center will also be the hub for all faculty members visiting from Norway.⁷ To assist UCSD faculty members spending time at the Simula Graduate School of Computing, Simula's administration will have a dedicated point of liaison on the Norwegian side.

In addition to physical presence at the two different locations, there will be need for frequent contact between the institutions. High-quality facilities for teleconferencing and remote lecturing will be used for several purposes, such as lectures targeting students at both sites simultaneously, virtual meetings between students and supervisors, administrative meetings, and project meetings between student teams located at different sites.

The existing collaboration between Simula and UiO supports the proposed program

Since the laboratory's establishment in 2001, UiO has collaborated closely with Simula on master's and PhD education. Prior to that, the initial research groups at Simula were parts of UiO. Today, 16 faculty members at Simula are also affiliated with UiO. In 2009, Simula's staff taught courses at UiO that produced close to 7,500 ECTS credits. During the period 2005–2009, Simula's average annual production accounted for 17 and 24 percent of the master's and PhD degrees awarded in UiO's Department of Informatics, respectively. The collaboration agreement between the two institutions also covers the creation of the Simula School of Research and Innovation (SSRI) in 2007. Currently, SSRI is a research school affiliated with UiO⁸, serving as the organizational anchor point for about 40 master's students, 40 PhD students, and 15 postdoctoral fellows supervised and located at Simula. This well established and functioning collaboration forms a strong foothold for developing the proposed joint graduate program.

⁷Provided sufficient interest from other Nordic universities collaborating with UCSD, the Simula school's service center could be developed to be a hub for Nordic researchers and students visiting UCSD, similar to the role of Scancor at Stanford University (see <http://www.scancor.org>).

⁸Overview of research schools affiliated with UiO. <http://www.uio.no/forskning/doktorgrad-karriere/forskerskoler/oversikt.html>.

Summary

The Simula Graduate School of Computing will implement an educational program in close collaboration with UCSD and UiO. This graduate program will be connected to bachelor's programs at UiO, and offer education at master's and PhD levels, ultimately leading to dual or joint degrees. It will provide research-based education of an interdisciplinary nature, be tightly coupled to joint research activities, and keep a special link to innovation and entrepreneurship. Well-organized exchanges of students and faculty members between the two countries will ensure a tight and fluent collaboration.

Master's level

- Two-year master's level component (120 ECTS credits)
- 30 study seats per year, total of 60 seats
- Taught in collaboration between Simula, UCSD, and UiO
- Students' time divided equally between Norway and the United States
- Degrees awarded from both UCSD and UiO

PhD level

- Three-year research education (180 ECTS credits)
- 20 study seats per year, total of 60 seats
- Taught in collaboration between Simula, UCSD, and UiO
- Students' time divided equally between Norway and the United States
- Degrees awarded from both UCSD and UiO.

Migrating research results from the laboratory to everyday life

Partnering with UCSD can potentially impact the innovation culture and the commercialization outcome at Simula and UiO. In particular, valuable connections to UCSD's environment for innovation and entrepreneurship will complement the proposed educational collaboration. As discussed in this chapter, this environment consists of academic centers and technology transfer offices, as well as industrial partners.

Simula is located next door to the largest knowledge-based companies in Norway

Simula's location at Fornebu is an excellent starting point for close collaboration with the Norwegian knowledge-based industry. In the immediate surroundings one finds the largest companies in the country, Statoil and Telenor. As indicated in the fact box on page 27, these companies are of considerable size in an international context as well. Enlarging the area of interest to Bærum, there are other large research-oriented companies such as Det Norske Veritas and Aker Solutions. In addition, an increasing number of small and medium-sized enterprises share a knowledge-based profile. Current dialog with Simula's existing industrial partners reveals a strong interest in the Simula Graduate School of Computing, in terms of becoming a strong scientific and technological hub, as well as a channel for the recruitment of highly competent personnel. From the perspective of the Simula school, industrial contacts are important to ensure the relevance of the education provided and underlying research. Moreover, several of these companies may become possible funding partners in the future, once the school has proved itself.

The demographic profile of the municipality of Bærum supports the view of this area as a cornerstone of the Norwegian knowledge-based industry. Public statistics on how the educational level of people over 16 years of age varies by geographical regions show that the inhabitants of Bærum are by far the best educated in Norway. The Bærum score of 46.4 percent of the population having higher education is complemented by the corresponding percentages for the two neighboring municipalities of Asker (44.1) and Oslo (43.8).¹ These three municipalities are the only ones surpassing the 40 percent level. In addition to signaling the immediate presence of workplaces requiring highly educated personnel, this demographic profile

¹Statistics for the educational level in the Norwegian population. <http://www.ssb.no/emner/04/01/utniv/tab-2010-06-25-02.html>.

is also encouraging for the recruitment of well-prepared and motivated students to the proposed educational program.

A partnership with UCSD will strengthen our power of innovation

Like other Norwegian organizations involved in technology transfer, Simula should focus on transfer models that are scalable and efficient. Experiences from Norway and the

United States show that industry collaboration and the licensing of technology have the highest value potential. However, it remains a challenge that Norwegian universities have modest participation from industry in their research. The low level of participation is partly due to cultural reasons, and partly related to the fact that only a few companies in Norway being large enough to make significant investments in academic research. The proposed collaboration with UCSD can address both of these issues.

Although the situation varies in the United States as well, the best universities have a strong relation between research and industry. American industry has a tradition of funding research at universities, and American universities have a culture for addressing industry in their research efforts. Within the technological areas of interest to Simula, important parts of the relevant industry have traditionally been based in the United States. In addition, important international companies rooted outside the United States tend to have a substantial American presence due to the importance of this market.

As a potential entry point to research-intensive industrial companies, collaboration with UCSD can benefit Norwegian partners by the university's immediate proximity to relevant industry. In fact, the San Diego area currently houses 6,000 technology companies employing almost 140,000 people, thereby representing 6 percent of the region's employers.² In many cases, these companies nurture connections to UCSD and the surrounding research environment. Moreover, a partnership with UCSD can be an effective door opener to new companies and industrial branches. Therefore, collaboration with UCSD can potentially accelerate our industrial impact, in particular by strengthening interest from R&D units within international companies.

²CONNECT. <http://www.connect.org>.

The Fornebu area

- The Fornebu area: 340 hectare
- Number of employees in the Fornebu area: 13,890
- Business premises, future development: 250,000 m²
- Prospective number of apartments: 6,300

Statoil

- International energy company with operations in 34 countries
- Largest oil and gas operator on the Norwegian continental shelf
- 29,000 employees worldwide
- Annual revenues: 465 billion NOK
- R&D spending: 2.1 billion NOK
- Headquarters at Fornebu (in development, finished 2012)

Telenor

- International telecommunications company with operations in 12 markets
- 34,000 employees worldwide
- Annual revenues: 107 billion NOK
- R&D spending: 236 million NOK
- Headquarters at Fornebu

Aker Solutions

- Leading global provider of engineering and construction services with operations in 30 countries
- 22,000 employees worldwide
- Annual revenues: 54 billion NOK
- R&D spending: 180 million NOK
- Main corporate office at Fornebu

Det Norske Veritas

- Leading global provider of risk assessment services with operations in 100 countries
- 9,000 employees worldwide
- Annual revenues: 10 billion NOK
- Headquarters at Høvik

Collaboration with UCSD provides experience and operational tools for innovation and entrepreneurship

UCSD demonstrates an impressive focus and track record in innovation and commercialization and strongly promotes these aspects in the institution's vision and goals. Through various instruments, over 200 start-ups have been generated from UCSD.³ As pointed out in Chancellor Fox's support letter on page xi, UCSD currently administers more than 1,400 active patents and around 375 active license agreements for university-developed technology. Over time, the university's technology transfer office has developed a comprehensive set of guidelines, procedures, and other tools designed to encourage and support the migration of research from the laboratory to everyday life.⁴

UCSD is also the origin of the organization CONNECT⁵, which was designed to assist researchers and inventors in commercializing research discoveries through education, mentoring, and access to capital. Since its establishment in 1985, CONNECT has assisted in the establishment and development of more than 2,000 companies. Currently, this organization has a presence in more than 40 countries worldwide, including a Norwegian branch, of which Simula is a member. Increased exposure to the international part of the CONNECT network will be a strength.

Scrutinizing UCSD and CONNECT's well-established instruments for industrial

collaboration and technology transfer, we believe that Simula, UiO, and other Norwegian actors in technology transfer can benefit substantially. In addition, this compound environment can provide effective

““ *We want to be the go-to place for academics and industry partners to do cutting-edge, multidisciplinary research and development to benefit society in California and beyond.* Ramesh Rao, Director of Calit2

entry points into attractive markets and access to potential investors and venture capitalists.

Complementing their regular academic courses, UCSD also offers courses and programs focusing on innovation, entrepreneurship, and leadership. Such provisions are available from the von Liebig Center⁶ and the Gordon Engineering Leadership Center⁷, both of which are organized under the Jacobs School of Engineering. As discussed in Chapter 3, these centers may contribute to the educational program.

³UC San Diego Technology Transfer Office. <http://invent.ucsd.edu>; UC San Diego Economic Impact Report. <http://ucsdnews.ucsd.edu/economicimpact>.

⁴UC San Diego Technology Transfer Office.

⁵CONNECT. <http://www.connect.org>.

⁶William J. von Liebig Center. <http://www.vonliebig.ucsd.edu>.

⁷Bernard and Sophia Gordon Engineering Leadership Center. <http://www.jacobsschool.ucsd.edu/GordonCenter>.

The California Institute of Telecommunications and Information Technology⁸ (Calit2) is a multidisciplinary research unit at UCSD that specializes in creating and supporting collaborations between academic departments and institutions, as well as industry partners. By its very nature, Calit2 is a melting pot for research and innovation. The institute offers state-of-the-art facilities and equipment, as well as administrative support. The Simula Graduate School of Computing will be affiliated with Calit2, which, although being a cross-campus unit, reports administratively to UCSD's Jacobs School of Engineering.

Summary

In recent dialogs, large knowledge-based companies already involved with Simula have revealed great interest and enthusiasm for the proposed collaboration with UCSD. The organization CONNECT, which originated at UCSD and later grew into a global network, plays an important role in the commercialization of research discoveries. The tools and experience provided by CONNECT are complemented by UCSD's renowned educational programs in leadership and innovation. Based on UCSD's excellent interaction with industry and dedicated efforts directed toward innovation and entrepreneurship, Simula and UiO can potentially experience a significant impact on innovation culture and commercialization outcomes.

⁸California Institute for Telecommunications and Information Technology. <http://www.calit2.net>.

5

Simula provides the framework for a strong international collaboration

Reports from the Government argue that a strong international academic collaboration requires an efficient framework and management. This chapter discusses the framework and operational model of the joint graduate program.

Effective management is required to unleash the power of collaboration

Compared to the traditional agreements frequently signed by collaborating academic institutions, the Simula Graduate School of Computing is a different, more integral way to launch and sustain an international collaboration. This initiative builds upon the experiences made in an evaluation of the Quality Reform¹ in 2007, which argues for increased internationalization in higher education:

Many institutions have developed good agreements with foreign institutions, which it is important to expand on, but in some cases the links between courses, faculties and management are too weak. It is important that internationalization is followed up with strategic priorities from managements, and the conclusion of the evaluation is that measures for promoting greater internationalization must be directed at several actors, not just at the students. A close link between education and research will also be important for succeeding in the work on giving internationalization a better academic foundation.

The operational framework is paramount to the success of the Simula Graduate School of Computing. As described in Chapter 2, Simula has an excellent scientific base for facilitating this initiative and can foster strong academic relations between the three partners. Complementing the scientific results, the Evaluation Committee of 2009 stated, “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.”² Certain mechanisms and organizational features are necessary to manage and sustain academic and institutional endeavors. In this respect, the way in which Simula is currently organized and operated provides

¹Ministry of Education and Research: Summary in English: Report No. 14 (2008–2009) to the Parliament, Internationalisation of Education in Norway. http://www.regjeringen.no/pages/2255014/PDFS/STM200820090014000EN_PDFS.pdf, page 13.

²Braun, T. et al.: Simula Research Laboratory, Scientific Evaluation. 2009, page 11.

strong advantages, enabling the collaboration to achieve valuable results in an effective manner.

Management model. Simula combines the strongest management features of academia and industry. The limited company model ensures Simula's flexibility and ability to operate and coordinate the academic collaboration in a smooth and efficient manner.

Directed research. At Simula, the research is more strongly directed than is the case at most universities, which enables Simula to focus on a limited number of projects, ensuring a close link between research and education. This method of operation allows one to focus on the adopted strategies of the Simula school.

Recruitment. The global race to attract top talent among both the staff and students affects academic institutions across the globe.³ The process of hiring scientists at universities is time-consuming and therefore the risk of losing excellent potential employees in the process is significant. In addition to standard hiring procedures, the limited company model provides Simula with the opportunity to headhunt special talents. In particular, this will prove to be an important feature in efficiently establishing the Simula Graduate School of Computing and delivering results.

Relations to UCSD. Simula has already established strong scientific connections to the faculty and management at UCSD. These relations ensure a strong and sustainable commitment and will enable efficient communication within the collaboration.

Relations to UiO. Simula has always had a strong relation to UiO, highlighted by the establishment of the SSRI. This relation is further described below.

Relations to industry. Simula focuses on innovation and applications in society and has strong relations to industry. This is best exemplified by the extensive collaboration between Simula and Statoil. Simula's operational approach of strongly directing its research activities is essential in enabling fruitful cooperation with industry partners.

The Simula Graduate School of Computing is the next step in the educational alliance between UiO and Simula

The Simula Graduate School of Computing fits in with the strategic intentions of UiO, and provides an opportunity for UiO to meet the objectives of their current strategy. As discussed in Chapter 2, UiO defines clear goals⁴ regarding internationalization. Under the heading "A university transcending borders," the university's first objective is as follows: "The University of Oslo shall promote pioneering research, education

³Wildavsky, Ben: *The Great Brain Race. How Global Universities Are Reshaping the World.* Princeton University Press, 2010.

⁴Strategy 2020 University of Oslo. <http://www.uio.no/om/strategi/Strategy2020English.pdf>, page 6.

and communication and be sought after as an international partner.” Of the strategies defined to meet this highly prioritized objective, the following is stated: “All educational programmes will be given an international profile and cooperation with foreign institutions will be increased in order to achieve greater relevance and a higher level of quality.” Furthermore, it is stated⁵ that

Internationalisation of study programmes will be enhanced through increased cooperation with strategic partners and through securing agreements with leading universities. Together with these universities, UiO will establish more and better international programmes, recruit more foreign students and increase the number of international lecturers participating in study programmes.

The Norwegian Association of Higher Education Institutions (UHR) states in a report⁶ that the establishment of dual or joint degrees entails more than just agreeing on academic cooperation:

The work group believes that joint degree cooperation implies strengthening of the academic environment that can provide great added value beyond the specific cooperation project. Transparency between research communities, strengthening of the common professional skills and increased recruitment, are added value expected to contribute to the improvement of the quality of education and research. This will also benefit the student. In addition to the social and academic gains that mobility can provide, having a degree that is recognized by several institutions and often in several countries is seen as a clear advantage for the student, as it will also open the door to an international labour market.

Simula regards establishment of the Simula Graduate School of Computing as a natural move that will further strengthen the alliance and expand the joint

educational activities with UiO in a strong international direction. The relation between UiO and Simula has been important since Simula’s inception in 2001, and it has been

“Development of dual or joint degrees is the most challenging, but probably also the most integral form of cooperation between institutions.”⁷

beneficial to the academic activities at both Simula and UiO. As described in Chapter 3, UiO has collaborated closely with Simula on master’s and PhD education since

⁵UiO Strategy 2020, page 7.

⁶The Norwegian Association of Higher Education Institutions: Rapport om fellesgradssamarbeid og cotutelle, June 2007. http://www.uhr.no/utdanning/utdanningsutvalget/sentrale_dokumenter, page 9. Our translation from Norwegian, see C-10.

⁷Ministry of Education and Research: Report No. 14 (2008–2009) to the Parliament, Internasjonalisering av utdanning. <http://www.regjeringen.no/pages/2152661/PDFS/STM200820090014000DDDPDFS.pdf>, page 60. Our translation from Norwegian, see C-11.

Joint degrees⁸

A joint degree can be said to have all or some of the following characteristics:

- The programs are developed and/or approved jointly by several institutions.
- Students from each participating institution physically take part in the study program at other institutions (but they do not necessarily study at all cooperating institutions).
- A student's stay at participating institutions should constitute a substantial part of the program.
- Periods of study and examinations passed at partner institutions are recognized fully and automatically.
- Partner institutions work out the curriculum jointly and cooperate on admissions and examinations.
- After completing the full program, students obtain either the national degree of each participating institution or a degree (usually an unofficial "certificate" or "diploma") awarded jointly by the partner institutions.
- The providing and awarding bodies must enter into the appropriate agreements before a collaborative program is validated or a joint award is made.

the laboratory's establishment. Prior to that, the initial research groups at Simula were parts of UiO. Today, most senior faculty members at Simula hold full or adjunct professorships at UiO, and Simula faculty is heavily involved in the teaching and supervision of students in UiO's undergraduate and graduate programs. An agreement that regulates the collaboration has been signed by the two institutions. This agreement concerns the division of infrastructure and personnel, research and innovation activities, and educational components such as the establishment of SSRI, which is a research school affiliated with UiO.⁹ The introduction to this agreement¹⁰ states,

⁸Recommendation on the Recognition of Joint Degrees. Adopted by the Committee of the Convention on the Recognition of Qualifications concerning Higher Education in the European Region on 9 June 2004. <https://wcd.coe.int/ViewDoc.jsp?id=836481&Site=COE>.

⁹Overview of research schools affiliated with UiO. <http://www.uio.no/forskning/doktorgrad-karriere/forskerskoler/oversikt.html>.

¹⁰Agreement between the University of Oslo and Simula Research Laboratory, signed April 2009. Our translation from Norwegian, see C-12.

Cooperation on education within informatics has been especially successful throughout the first contract period. Employees at Ifi, that are affiliated with Simula, participate in teaching and supervision at Ifi, and have been central in the development of new courses and educational programmes. The creation of the Simula School of Research and Innovation at the University of Oslo (SSRI) in 2007 is also the most tangible goal for education reached. Continued cooperation between Simula and the University of Oslo will focus on further strengthening of education, both at SSRI and Ifi.

UNIS can serve as an operational model for the Simula Graduate School of Computing

As previously mentioned, certain organizational features are necessary to manage and sustain the academic efforts that the Simula Graduate School of Computing entails. Simula's organization already holds strong advantages to this end and can, with some adjustments, unlock even greater potential. The University Centre in Svalbard (UNIS)¹¹ is located in Longyearbyen in Svalbard and is thus the world's northernmost institution of higher education. UNIS has an operational model that enables the center to flourish:

In the beginning UNIS was conceived as an Arctic college. Lower level courses dominated the catalogue. In 2001 UNIS received funding for the first PhD position. In 2010 we have approximately 25 PhDs and post docs at UNIS. We are clearly developing in the direction of a graduate school.¹²

UNIS shares several features with Simula, and its operational model proves to hold interesting characteristics that fit the Simula Graduate School of Computing very well. Both are organized as limited companies owned by the Ministry of Education and Research. In the same way as Simula, UNIS offers high-quality courses and teaching at the undergraduate, graduate, and postgraduate levels in different areas within its scientific expertise. Neither fulfills the given set of standards needed to be accredited as understood in the act relating to universities and university colleges. Therefore, the educational activities at both Simula and UNIS are intended to complement the degrees awarded by the university partner.

From conversations with the administration at UNIS, we have learned that UNIS employs faculty in academic positions as professors or assistant professors. Provided that the expert assessment of the applicants to such positions is undertaken by a university or similar institution with the authority to conduct such assessments, UNIS can recruit scientific personnel to specific UNIS professorships.

¹¹The University Centre in Svalbard. <http://www.unis.no>.

¹²Gunnar Sand, managing director of UNIS in the UNIS Annual Report 2009, page 3.

The Simula school needs the level of flexibility that is observed in the UNIS model:

- UNIS' funding model stimulates and encourages cooperation with other Norwegian universities.
- UNIS' funding is adjusted annually for wage and price inflation.
- UNIS receives Government funding earmarked for PhD positions, as well as study seats (see also Chapter 6).

It seems natural to build a new educational provision based on an already existing model within the Norwegian education system.

Summary

The initiative is well aligned with UiO's current strategies on internationalization and the Simula school is a natural expansion of Simula's existing academic collaborations with UiO. Enabled by strong connecting ties to both UiO and UCSD and the advantages provided by Simula's management platform, Simula will be an efficient operator and will provide the framework for the collaboration. The already existing model employed by UNIS will serve the purpose for the operation of the Simula Graduate School of Computing.

6

The financial implications of the proposed educational alliance

Realization of the Simula Graduate School of Computing will require stable, long-term funding from the Government. When running at full capacity, the school will house 60 PhD students and 60 master's students. As stepping stones in a ramp-up plan to reach this state, we propose starting the implementation at the PhD level and thereafter adding the master's level. The first step, realizing the PhD program on top of Simula's existing educational activity, requires a new annual funding of 25 million NOK. The second step, which adds the master's level education, costs another 14 million NOK, thereby increasing the annual funding requirement to 39 million NOK. These estimates assume that Simula's currently funded PhD positions are phased in to become parts of the school. It is also suggested that the bachelor's program at UiO are financially strengthened and tailored to deliver candidates that are well suited for collaborative studies at UiO, UCSD, and Simula.

Graduate students can be recruited from tailored bachelor's programs at UiO

As discussed in Chapter 3, UiO will play an important role in the recruitment of students to the Simula Graduate School of Computing. To ensure local access to well qualified students who have been primed for the graduate-level educational collaboration between Simula, UCSD, and UiO, we propose the allocation of 90 bachelor's level study seats at UiO. These seats can be associated with already existing programs, or be the basis for a new bachelor's program. Although such programs would be the responsibility of UiO, the Simula school would be ready to assist in the specification and implementation of these educational provisions to ensure a smooth integration with the proposed graduate program. This integration, which aims at dual or joint degrees, would become much stronger if the bachelor's students are provided with a carefully implemented program for student exchange between UiO and UCSD, specifically addressing the disciplines of interest to the Simula school. Being outside the scope of the Simula Graduate School of Computing, the funding requirements of undergraduate study seats are not discussed in this proposal.

Students	Rates 2011		Funding	
	Strategic	Production	Strategic	Production
60	98	65	5,880	3,900
Annual amount				9,780

Table 6.1: This table presents the estimated governmental funding for new seats at the master's level, to be split equally between UiO and the Simula Graduate School of Computing.

The joint master's program requires 14 million NOK of annual funding

The Simula Graduate School of Computing will offer a joint program in close collaboration with UiO and UCSD, leading to dual or joint degrees as described in Chapter 3. To genuinely support the educational collaboration, 60 new master's level study seats should be allocated. Such study seats are funded annually by a combination of two rates.¹ Each year, the institution receives a certain rate (strategic) for each allocated study seat. In addition, it receives another rate (production) for each unit of 60 ECTS credits that was produced two years earlier. The actual rates, as shown in the column Rates 2011 in Table 6.1, correspond to category C funding.² Under perfect conditions, all students will have a normed progression, that is completing 60 ECTS credits of course and thesis work each year. In that case, the total funding of study seats would be 9.8 million NOK annually. This amount should be divided equally between UiO and Simula as equal partners on the Norwegian side.

Based on a detailed cost analysis, we have concluded that the collaboration with UCSD for a joint Norwegian-American master's level education will add 67,000 NOK to the annual cost per student. This type of additional cost remains independent of the executing organization. Applying this cost estimate to the proposed program of 60 master's students, there is need for an additional funding component of 4 million NOK to the Simula school. This amount will cover travel and accommodation for the students, who are expected to share their time equally between Norway and the United States. In addition, it covers the proportional part of the costs of a dedicated service center at UCSD, and the expenses connected to faculty members from Norway visiting UCSD, see Chapter 3.

¹Throughout this chapter, all estimates are based on price levels valid for 2010–2011 and on educational funding rates for 2011. All monetary amounts listed in the tables are given in units of 1,000 NOK.

²Ministry of Education and Research: Orientering om forslag til statsbudsjettet 2011 for universiteter og høyskoler. <http://www.regjeringen.no/upload/KD/Vedlegg/UH/St.prp%201/F-4259BlaattHefteENDELIG.pdf>, page 49.

	Students	Rates 2011	Funding
New PhD positions	60	850	51,000
US collaboration	60	140	8,400
<i>Subtotal</i>			<i>59,400</i>
Existing PhD positions	-40	850	-34,000
Annual amount			25,400

Table 6.2: This table presents the amount of funding required for PhD positions and the corresponding mobility costs arising from the collaboration with UCSD. The total cost is reduced corresponding to the 40 PhD positions already existing at Simula, under the assumption that the existing level of research education will continue and be embedded in the Simula Graduate School of Computing.

The analysis of mobility costs caused by the transatlantic collaboration assumes that potential tuition fees are handled separately. This topic is discussed further on page 39. Consequently, the annual funding requirement for the master's level component of the Simula Graduate School of Computing will be 13.8 million NOK, of which 4.9 million NOK should be granted to UiO and 8.9 million NOK to the Simula school.

The joint PhD program requires 25 million NOK of new annual funding

Simula has already a strong foothold in research education. Over recent years, the average number of PhD positions at Simula has been 40. These positions are financed by three different sources: Simula's existing basic allowance, research projects granted by the Research Council of Norway, and research projects sponsored by industrial partners. Assuming that this level of funding is sustained and the associated PhD positions become part of the Simula Graduate School of Computing, only 20 new positions needs to be allocated to reach the goal of 60 active PhD students. The analysis of mobility costs caused by the close collaboration with UCSD, indicates that each PhD student will cost 140,000 NOK annually in addition to the standard rate³ of 850,000 NOK. Table 6.2 shows that the total of 60 PhD positions in a transatlantic collaborative program will cost 59.4 million NOK. However, the 40 PhD positions imported from Simula's existing level of activity reduce this cost by 34 million NOK, causing the funding requirement to be 25.4 million NOK annually.

³In 2009, this public rate was 800,000 NOK, see Ministry of Education and Research: Orientering om forslag til statsbudsjettet 2009 for universiteter og høyskoler. http://www.regjeringen.no/nb/dep/kd/dok/veiledninger_brosjyrer/2008/Orientering-om-statsbudsjettet-2009-for-universiteter-og-hoyskoler.html?id=619679, page 33.

Similar to the cost estimation for the master's level education, the calculation of mobility costs for PhD students excludes any tuition fees at UCSD. This topic is discussed further below. The indicated mobility cost for PhD students accounts for travel and accommodation expenses, based on the assumption that these students on the average will divide their time equally between Norway and the United States. Moreover, it covers the proportional part of the school's service center at UCSD's main campus, and costs accruing due to faculty members from Norway visiting UCSD.

The principle of free education implies that students at the Simula school should not be charged tuition fees

In the discussion above, we have not included any tuition fees for education and supervision conducted by UCSD. We anticipate that such fees will be a target for negotiations with UCSD, which can not be entered before a reasonable level of certainty with respect to funding has been received. However, in her support letter on page xiv, UCSD's Chancellor Marye Anne Fox states that

In addition to the services for international students described above, UC San Diego will support the collaboration through faculty, professional staff and teaching assistant salaries. At the graduate level, MS and PhD students will have access to well-funded research laboratories and world class research facilities, including the high-performance computing resources at San Diego Supercomputer and Calit2.

This statement concerning in-kind contributions will be a starting point for negotiations aimed at reducing or waiving UCSD's tuition fees for the Simula school's students.

Based on the fundamental Norwegian policy of making education available to everyone, regardless of nationality or financial means, participating students in a joint program should not be charged tuition fees. If the negotiation with UCSD concludes that a certain fee is due for each student, the policy of free education can be fulfilled by granting the students at the Simula school the same financial support as a student starting regular studies at an American university. Students entitled to Norwegian support for studies and who pursue a mobile degree as a full-time student abroad qualify for extended scholarships to cover tuition fees, depending on the chosen university. UCSD is on the list of qualified institutions.⁴

The Norwegian State Educational Loan Fund has stated⁵ that students in the proposed educational program would not automatically qualify for scholarships

In communication with the Ministry of Education and Research, we have been informed that the 2011 rate will be 850,000 NOK.

⁴Norwegian State Educational Loan Fund: Information concerning extended scholarships and educational loans for studies abroad. <http://www.lanekassen.no/Hovedmeny/Stipend-og-lan/Utland/Hvor-mye/Tilleggsstipend>.

⁵Private communication dated September 29, 2010.

covering tuition, despite the role played by UCSD. It was pointed out, however, that the Ministry of Education and Research can define such a mandate for the Educational Loan Fund.

The proposed program should be implemented in two steps

To reduce financial risk and provide the time needed to assure high quality, implementation of the Simula school's program should be carried out in two steps over a period of two to three years. It is reasonable to initiate the educational collaboration by first concentrating on the PhD level. With this approach, the Simula Graduate School of Computing will draw upon experiences from SSRI's existing operations in research education, which today is mainly conducted in collaboration with UiO. Moreover, Simula's current research collaboration with UCSD can easily be extended to include new PhD students, even in parallel with the processing of regulations needed to realize dual degrees or a joint degree between UiO and UCSD. At the start-up of the proposed program, 20 new PhD positions and mobility costs for all the 60 PhD students should be granted at the annual cost of 25.4 million NOK. Taking into account Simula's already existing PhD positions, a total of 60 PhD students will then be active in the program.

Due to the coming growth of age groups that will put undergraduate study seats in demand, there is political focus on the capacity of Norwegian bachelor's programs, an issue of concern to UiO as well. It is also of interest to Simula to see bachelor's programs aimed at the collaboration with UCSD being developed at UiO. This initiative should be taken as early as possible, preferably in parallel with the start-up of the PhD component, to establish a well-designed recruitment pipeline for the joint Norwegian-American program.

After the first two years of the Simula school's operation, the proposed component for master's level education should be added. Assuming that the bachelor's programs at UiO at this point in time will deliver a steady stream of well-suited candidates, the master's program will complete the educational pipeline from bachelor's to PhD level. That is, at this final stage, 60 master's students and 60 PhD students will take part in the Simula Graduate School of Computing's program. Running this program at full capacity will increase the funding requirement by 13.8 million NOK, from 25.4 million NOK to 39.2 million NOK annually.

Taking into account the levels of public funding⁶ and reported output of completed degrees⁷ for Norwegian educational institutions, the indicated level of investment in the Simula school will have significant impact. As stated in Chapter 1, the proposed program will more than double the number of students pursuing a US doctoral degree with Norwegian support and will have a substantial impact on

⁶Ministry of Education and Research: Orientering om forslag til statsbudsjettet 2010 for universiteter og høyskoler. http://www.regjeringen.no/nb/dep/kd/dok/veiledninger_brosjyrer/2009/statsbudsjettet-2010-orientering-for-uni.html?id=593915.

⁷Database for statistics on higher education in Norway. <http://dbh.nsd.uib.no>.

the number of master's students within technology and engineering. Through the educational provisions described in Chapter 3, these students will stand out as future leaders in a knowledge-based society. These results can be obtained with funding that is comparable to the public funding of a small regional university college.

Summary

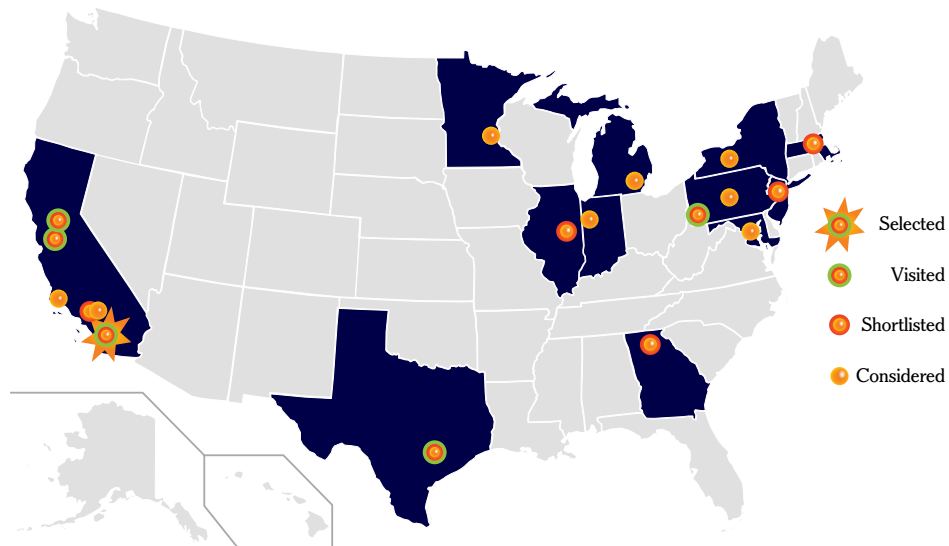
This chapter describes the funding requirements for implementing Simula Graduate School of Computing's program, which will provide training for 60 PhD students and 60 master's students. We suggest that the program be implemented over a period of two to three years to ensure the needed quality and reduce financial risk. The first step, realizing a PhD component of 60 students, will require 25 million NOK annually, while the second step of adding 60 master's students increases the total cost to 39 million NOK annually. In its full implementation, 40 PhD positions are contributed from Simula's existing economy, representing a value of 34 million NOK.

The program's cost can be largely covered by the traditional funding of study seats and new PhD positions. However, this funding needs to be complemented by an amount covering the mobility costs related to the collaboration with UCSD. The costs associated with training and supervision carried out by UCSD personnel may be brought down to a minimum or waived through in-kind contributions from UCSD, rather than being covered by regular tuition fees. The exact details concerning this matter will be subject to forthcoming negotiations. If tuition fees can not be eliminated, the Norwegian State Educational Loan Fund needs a mandate to let the existing funding mechanisms for studies abroad apply to the Simula school's students.

APPENDIX

A

The process of identifying a potential university partner



Surveyed institution	State		Surveyed institution	State	
UC Santa Barbara	California	●	Univ. of Illinois at Urbana-Champaign	Illinois	●
California Institute of Technology	California	●	Georgia Institute of Technology	Georgia	●
University of Minnesota	Minnesota	●	Princeton University	New Jersey	●
Purdue University	Indiana	●	MIT	Massachusetts	●
University of Michigan	Michigan	●	Stanford University	California	●
Pennsylvania State University	Pennsylvania	●	UC Berkeley	California	●
Cornell University	New York	●	University of Texas at Austin	Texas	●
University of Maryland	Maryland	●	Carnegie Mellon University	Pennsylvania	●
UC Los Angeles	California	●	UC San Diego	California	★

1 A short list of 10 candidates for collaboration

In February 2010, Simula’s management compiled a list of 18 top-ranked US universities that have a high standing in one or more of Simula’s research areas. The

map and table on the previous page list the 18 universities and indicate how far in the process each institution was included. This list was presented to all researchers at Simula through an online survey, where the respondents were asked to comment on each university's overall standing and its relevance to the respondent's field of research. Based on the responses, which were largely given by senior personnel, the list was narrowed down to 10 institutions.

The 10 candidates were discussed with the Science Counsel at the Norwegian Embassy in Washington, DC, and the Director of the Council of Graduate Schools¹, the only national organization in the United States dedicated solely to the advancement of graduate education and research. Based on these discussions and e-mail correspondence with senior executives at the different universities, five institutions were selected for visits by members of Simula's corporate management: Texas University at Austin; the University of California, Berkeley; Stanford University; the University of California, San Diego (UCSD); and Carnegie Mellon University (CMU).

2 Visits at five of the candidates

In April 2010, two representatives from Simula's corporate management visited the five universities listed above. On all occasions they met with senior administrative staff, often complemented by senior faculty members. The attendees demonstrated a firm knowledge of local policies and substantial experience with prior international collaboration.

A wide range of collaboration models was discussed in all meetings, with a local presence of the US university in Norway as the most ambitious option. Without exception, the visited universities expressed strong interest in collaboration with Simula. However, at Berkeley and Stanford it was clear that the establishment of a Norwegian branch would be incompatible with existing policies. The three other institutions expressed a strong interest in exploring the possibility of establishing a local presence at Simula.

Upon return to Norway, the responses from the visited universities were presented to the senior scientific staff at Simula. Their reaction was unanimous: Establishment of a branch of a US university at Simula is the best foundation for educational collaboration. In particular, the opportunity to design an integrated study path in computing from the bachelor's to the PhD levels was regarded to have a very high potential.

Continued internal discussions at Simula led to an outline of a satellite campus, which was presented to the Ministry of Education and Research, politicians, industrial partners, the University of Oslo, board members, and other stakeholders at a strategy summit on June 11, 2010. At that meeting, all parties welcomed the initiative, and the Ministry expressed interest in receiving a more detailed proposal for a tightly integrated educational collaboration between Simula and an American university. Continued discussions paved the way for a three-fold alliance involving Simula, the

¹Council of Graduate Schools. <http://www.cgsnet.org>.

preferred American partner, and UiO. The current report manifests the proposal for the implementation of such an alliance.

3 Continued dialog with UCSD and CMU

Immediately following the strategy summit in June, a summary of the discussion was provided to the three universities that had expressed interest in exploring a Norwegian branch. Of these three, UCSD and CMU continued the dialog with Simula, discussing in greater detail how such a presence could be implemented.

UCSD and CMU are both attractive alternatives, but with very different profiles. While UCSD and Simula share a long-standing, positive experience of research collaboration, CMU is a new acquaintance to Simula. On the other hand, CMU has a well-proven track record of international collaboration in terms of joint educational programs and the establishment of satellite campuses abroad, whereas UCSD has less international experience from educational collaboration. These two institutions are also quite different in size and organization: UCSD is a public university with more than 27,000 students, whereas CMU has around 11,000 students and is private.

4 UCSD as the chosen partner

After processing the information gathered from the conducted meetings and the general information available about CMU and UCSD, Simula's corporate management preferred UCSD as the educational partner. This judgment was based on several criteria. First of all, Simula and UCSD have had a close research collaboration in the area of scientific computing since 2002. In addition, UCSD houses relevant scientific groups within Simula's other fields of interest. Concerning the prospect of establishing a tight educational alliance, UCSD was observed to have a strong commitment toward establishing a practical and robust framework for collaboration. It may seem as if UCSD has wider recognition among young people than CMU, at least in Norway. Combined with the observation that California is a highly ranked destination by Norwegian students studying abroad, UCSD stood out as the stronger candidate in terms of student recruitment.

APPENDIX

B

Dialogue with stakeholders

1 Strategy seminar of June 11, 2010

In June 2010, Simula's proposal on entering into a strong formal collaboration with an American university partner was presented at a strategy summit attended by board members and selected stakeholders, ranging from politicians to partners in academia and industry. In addition to the employees of Simula, the following representatives attended the seminar:

- Marianne Aasen, Chair of the Standing Committee on Education, Research and Church Affairs at the Parliament
- Kyrre Lekve, State Secretary for Higher Education, Ministry of Education and Research
- Erling Dietrichsson, Senior Adviser, Ministry of Education and Research
- Professor Morten Dæhlen, Head of the Department of Informatics, UiO
- Christian Hambro, Lawyer, Gram, Hambro & Garman
- Dagfinn Myhre, Senior Vice President, Telenor
- Harald Holm Simonsen, Senior Adviser, Research Council of Norway
- Odd Reinsfelt, Mayor of Bærum Municipality
- Nina Bønsnes Røed, Head of Development, Bærum Municipality
- Gro Haugland, Head of Business Affairs, Bærum Municipality

Board of Directors, Simula Research Laboratory (SRL)

- Ingvild Myhre, Chair
- Tormod Hermansen
- Mats Lundqvist, Director, Chalmers School of Entrepreneurship
- Inger Stray Lien, Senior Adviser, the University Management Office, UiO
- Professor Gunnar Hartvigsen, Vice Dean, University of Tromsø

Board of Directors, Simula School of Research and Innovation (SSRI)

- Professor Annik M. Myhre, Dean of Education at the Faculty of Mathematics and Natural Sciences, UiO
- Hilde Lovett, Senior Researcher, Telenor
- Ingolf Søreide, Vice President, Statoil
- Morten Frogner, Executive Vice President, Umoe



Figure B.1: Facsimile from Budstikka 14 June 2010.

2 Discussions of the proposal at board meetings

In addition to the board meeting prior to the strategy seminar of June 11, the proposal had been an item on the agendas of both the board of directors for SRL and the SSRI. The Board of SRL discussed the proposal on October 6 and again on November 30, 2010. The Board of SSRI discussed the proposal on September 21 and November 19, 2010.

3 Discussions of the proposal with UiO

Being the proposed Norwegian university partner in the educational collaboration, the University of Oslo has been informed about the progress of the proposal. In addition to several informal exchanges of information, the following formal transactions have taken place:

Strategy seminar, June 11, 2010

In addition to board members Annik Myhre and Inger Stray Lien, Professor Morten Dæhlen, Head of the Department of Informatics, attended the strategy seminar.

Formal invitation to dialog sent to UiO August 6, 2010

In a letter dated August 6, 2010, Simula invited UiO to discuss the proposal.

Meeting with the Faculty of Mathematics and Natural Sciences

On October 21, Simula's management had a meeting about the proposal at UiO with the Dean of the Faculty of Mathematics and Natural Sciences, professor Knut Fægri, and Morten Dæhlen.

4 Dialog with other stakeholders

In relation to the strategy seminar, partners in industry and academia (as listed below) were invited to a continued dialog about the proposal. Some of them were present at the strategy seminar, and a continued dialog has been ongoing with several of them in parallel with the writing of the proposal. Some of the invited stakeholders did not respond to the invitation to take part in a dialog.

- Abelia
- Akershus fylkeskommune
- BI
- Bærum kommune
- DNV
- Hewlett Packard
- IKT Norge
- ITFBU
- NFR
- NTNU
- Statoil
- Tekna
- Telenor
- University of Bergen
- UNIK

C

Overview of quotes translated from Norwegian

Quote C-1 *Vi trenger flere studenter i de land vi har mye samhandel med, og hvor forskning og utvikling står sterkt. Vi trenger flere studenter som tar hele graden ute. Vi trenger flere studenter ute i realfag og teknologiske fag. Vi trenger studenter med gode kunnskaper i engelsk og evne til kommunikasjon og formidling.*¹

Our translation:

We need more students in the countries we have much trade with, and where research and development is strong. We need more students pursuing degrees abroad. We need more students abroad within science and technology. We need students with good knowledge of English and skills within communication and outreach.

Quote C-2 *Framtidens verdiskapning forutsetter global konkurransedyktighet. Til dette trengs relevant utdanning av høy kvalitet, og det trengs samfunnsborgere og arbeidstagere med internasjonal kunnskap og erfaring.*²

Our translation:

The future value creation assumes global competitiveness. For this we need relevant education of high quality, and we need citizens and employees with international knowledge and experience.

¹NHO: Horisont 2008. Kunnskap og kompetanse. http://www.nho.no/getfile.php/bilder/RootNY/filer_og_vedlegg1/horisont_1_2008_lav.pdf.

²Ministry of Education and Research: Report No. 14 (2008–2009) to the Parliament, Internasjonalisering av utdanning. <http://www.regjeringen.no/pages/2152661/PDFS/STM200820090014000DDDPDFS.pdf>.

Quote C-3 *Internasjonalisering skal brukes som et verktøy for å kunne måle seg opp mot andre, og være et tilsvar til utfordringer som globaliseringsprosessene gir. Internasjonalisering skal gi høyere faglig kvalitet og gi økt relevans for elever og studenter til å møte utfordringene i et flerkulturelt og internasjonalt orientert samfunns- og arbeidsliv. I høyere utdanning skal internasjonalisering være et verktøy for institusjonene til å utvikle kvalitet og attraktivitet.*³

Our translation:

Internationalization shall be used as a tool to measure up against others and be a response to the challenges posed by globalization processes. Internationalization shall result in higher academic quality and provide greater relevance for pupils and students to meet the challenges of multicultural and internationally oriented businesses and communities. In higher education, internationalization shall be a tool for institutions to develop quality and attractiveness.

Quote C-4 *Det er også viktig at det i sammenheng med økt internasjonalisering utvikles bedre koblinger mellom utdanning og forskning. På den ene siden er det ønskelig å sikre større bredde i rekruttering til forskning, men også overføring av kunnskap og involvering av spesielt masterstudenter i prosjekter kan ha stor betydning. Studentutveksling, der dette ses i nær sammenheng med ulike fagmiljøer som samarbeider tett med hverandre, antas å være spesielt verdifullt.*⁴

Our translation:

It is also important that in the context of increased internationalization, better links are developed between education and research. On the one hand, it is desirable to ensure greater broadness of recruitment for research, but also the transfer of knowledge and the involvement of master's students especially in research projects can have great significance. Student mobility, where this is seen in close connection with research groups that work tightly together, is believed to be particularly valuable.

Quote C-5 *De overordnede målene for satsingen er å styrke elevenes og studentenes kompetanse i realfag, øke interessen for realfag og styrke rekrutteringen og gjennomføringen på alle nivåer...*⁵

Our translation:

The overall objectives of the initiative are to enhance pupils' and students' competence in science, increase the interest in science, and strengthen the recruitment and progression at all levels...

³Ministry of Education and Research: Report No. 14 (2008–2009), page 11.

⁴Ministry of Education and Research: Report No. 14 (2008–2009), page 63.

⁵Ministry of Education and Research: RealFag for framtida. Strategi for styrking av realfag og teknologi 2010–2014. <http://www.regjeringen.no/upload/KD/RealFagstrategi.pdf>, page 5.

Quote C-6 *Likevel er det langt igjen til OECD-nivå, og departementet anser fortsatt at rekruttering er en stor utfordring som må møtes med solide tiltak i strategiperioden.*⁶

Our translation:

There is nevertheless a long way to go to reach the OECD level, and the Ministry still reckons that recruitment is a great challenge that must be met with sturdy measures in the strategy period.

Quote C-7 *Jeg ser positivt på at statistikken fra de siste par årene viser en positiv trend når det gjelder studenter som tar en full studiegrad i USA, etter at det har vært en nedgang i antallet i en årrekke. Regjeringen håper at denne trenden fortsetter.*⁷

Our translation:

I consider it positive that the statistics from the last few years show a positive trend when it comes to students taking a full academic degree in the United States, after a decline for several years. The Government hopes that this trend continues.

Quote C-8 *Å legge til rette for at flere kan ta en kombinasjonsutdanning hvor man tar noen år ved en institusjon i Norge og de resterende i utlandet, kan være en måte å stimulere til studier i utlandet på, samtidig som man ivaretar den særegne faglige kompetansen man får i Norge innenfor det spesifikke faget.*⁸

Our translation:

A way to encourage more studies abroad is to facilitate combinations of Norwegian and foreign education where students can study a few years at an institution in Norway and the rest abroad, while maintaining the distinctive professional skills obtained in Norway in the specific subject.

⁶Ministry of Education and Research: Realfag for framtida, page 21.

⁷Ministry of Education and Research: Press release published on the Ministry of Education and Research's website August 26, 2010. <http://www.regjeringen.no/nb/dep/kd/aktuelt/nyheter/2010/flere-studenter-tar-utdanning-i-utlandet.html?id=613014>.

⁸ANSA: Tiltak for økt mobilitet og kvalitet. http://www.ansa.no/Om_ANSA/Politikk/Tiltak-for-okt-mobilitet-og-kvalitet.

Quote C-9 *Mulighet for direkte overgang fra masterstudiet til ph.d.-studier har støtte fra flere instanser, deriblant Norges forskningsråd og Doktorgradsstudentenes interesseorganisasjon ved NTNU (DION). Slike ordninger har potensial til å kunne øke gjennomføringsgraden i norsk forskerutdanning, samt bringe gjennomsnittsalderen ved avlagt doktorgrad ned.*⁹

Our translation:

The possibility of smooth transition from master's to PhD studies have support from several agencies, including the Research Council of Norway and the doctoral students' association at NTNU (DION). Such arrangements have the potential to increase the completion rate in the Norwegian research training, and bring down the average age of completed doctoral degrees.

Quote C-10 *Arbeidsgruppen mener at felles gradssamarbeid innebærer styrking av fagmiljøet som kan gi stor merverdi ut over det konkrete samarbeidsprosjektet. Transparens mellom fagmiljøene, styrking av den felles faglige kompetansen og økt rekruttering, er merverdier som forventes å bidra til heving av kvaliteten på utdanning og forskning. Dette vil også komme studenten til gode. I tillegg til de sosiale og faglige gevinster som mobilitet kan gi, vil det å ha en grad som er godkjent av flere institusjoner og som oftest i flere land, sees som en klar fordel for studenten, da det også vil åpne døren til et internasjonalt arbeidsmarked.*¹⁰

Our translation:

The work group believes that joint degree cooperation implies strengthening of the academic environment that can provide great added value beyond the specific cooperation project. Transparency between research communities, strengthening of the common professional skills and increased recruitment, are added value expected to contribute to the improvement of the quality of education and research. This will also benefit the student. In addition to the social and academic gains that mobility can provide, having a degree that is recognized by several institutions and often in several countries is seen as a clear advantage for the student, as it will also open the door to an international labour market.

Quote C-11 *Utvikling av felles grader er det mest krevende, men antakelig også den mest integrerende form for samarbeid mellom institusjoner.*¹¹

Our translation:

Development of dual or joint degrees is the most challenging, but probably also the most integral form of cooperation between institutions.

⁹Ministry of Education and Research: Report No. 14 (2008–2009), page 56.

¹⁰The Norwegian Association of Higher Education Institutions: Rapport om fellesgradssamarbeid og cotutelle, June 2007. http://www.uhr.no/utdanning/utdanningsutvalget/sentrale_dokumenter.

¹¹Ministry of Education and Research: Report No. 14 (2008–2009), page 60.

Quote C-12 *Samarbeidet om informatikk-utdanning har vært særdeles vellykket gjennom den første avtaleperioden. Ifi-ansatte med tilknytning til Simula deltar i undervisning og veiledning på Ifi, og har vært sentrale i utviklingen av nye kurs og utdanningsstilbud. Med etableringen av Simula School of research and Innovation at the University of Oslo (SSRI) i 2007 er også det mest konkrete målet for utdanningssiden nådd. Det videre samarbeidet mellom Simula og UiO vil dreie seg om å styrke utdanningsstilbudet ytterligere, både i SSRI og på Ifi.*¹²

Our translation:

Cooperation on education within informatics has been especially successful throughout the first contract period. Employees at Ifi, that are affiliated with Simula, participate in teaching and supervision at Ifi, and have been central in the development of new courses and educational programmes. The creation of the Simula School of Research and Innovation at the University of Oslo (SSRI) in 2007 is also the most tangible goal for education reached. Continued cooperation between Simula and the University of Oslo will focus on further strengthening of education, both at SSRI and Ifi.

¹²Agreement between the University of Oslo and Simula Research Laboratory. 2009.

References

Bernard and Sophia Gordon Engineering Leadership Center. <http://www.jacobsschool.ucsd.edu/GordonCenter>

California Institute for Telecommunications and Information Technology. <http://www.calit2.net>

CONNECT. <http://www.connect.org>

Council of Graduate Schools. <http://www.cgsnet.org>

Database for statistics on higher education in Norway. <http://dbh.nsd.uib.no>

Declaration on Educational Exchange between the United States and Norway. http://www.regjeringen.no/upload/KD/Vedlegg/UH/Internasjonalt/Deklarasjon_Nord-Amerika-strategien.pdf

Introduction: A Different Kind of College Ranking. http://www.washingtonmonthly.com/college_guide/feature/introduction_a_different_kind_2.php

A Note on Methodology: 4-year Colleges and Universities. http://www.washingtonmonthly.com/college_guide/feature/a_note_on_methodology_4year_co.php

Overview of research schools affiliated with UiO. <http://www.uio.no/forskning/doktorgrad-karriere/forskerskoler/oversikt.html>

Recommendation on the Recognition of Joint Degrees. Adopted by the Committee of the Convention on the Recognition of Qualifications concerning Higher Education in the European Region on 9 June 2004. <https://wcd.coe.int/ViewDoc.jsp?id=836481&Site=COE>

Statistics for the educational level in the Norwegian population. <http://www.ssb.no/emner/04/01/utniv/tab-2010-06-25-02.html>

Strategy 2020 University of Oslo. <http://www.uio.no/om/strategi/Strategy2020English.pdf>

UC San Diego Economic Impact Report. <http://ucsdnews.ucsd.edu/economicimpact>

UC San Diego Technology Transfer Office. <http://invent.ucsd.edu>

UCSD Receives Top Ranks in Doctoral Programs. <http://ogs.ucsd.edu/nrc-results.html>

- The University Centre in Svalbard. <http://www.unis.no>
- US News: Ranking of US Engineering Schools. <http://rankings.usnews.com/best-graduate-schools/top-engineering-schools/rankings>
- Washington Monthly Ranks UC San Diego 1st in the Nation for Commitment to Service. <http://ucsdnews.ucsd.edu/newsrel/awards/08-23MonthlyRanks.asp>
- Washington Monthly's 2010 national universities rankings. http://www.washingtonmonthly.com/college_guide/rankings_2010/national_university_rank.php
- William J. von Liebig Center. <http://www.vonliebig.ucsd.edu>
- Agreement between the University of Oslo and Simula Research Laboratory. 2009
- ANSA:** Tiltak for økt mobilitet og kvalitet. http://www.ansa.no/Om_ANSA/Politikk/Tiltak-for-okt-mobilitet-og-kvalitet
- Bernander, John G.:** Må ha relevante partnere. Debate in Aftenposten, June 9, 2010
- Berzins, M. et al.:** Evaluation of the Simula Research Laboratory. The Research Council of Norway, 2004
- Braun, T. et al.:** Simula Research Laboratory, Scientific Evaluation. 2009
- Higher Education, The Norwegian Centre for International Cooperation in:** Nyheter fra SIU. <http://www.siu.no/Konferanser-og-publikasjoner/Nyheter-fra-SIU-2010/Flere-norske-studenter-vil-til-USA>
- Ministry of Education and Research:** Kunnskapsdepartementets Nord-Amerika strategi for høyere utdanningssamarbeid 2008–2011. <http://www.regjeringen.no/upload/KD/Vedlegg/UH/Internasjonalt/NA%20Strategi08.pdf>
- Ministry of Education and Research:** Orientering om forslag til statsbudsjettet 2009 for universiteter og høyskoler. http://www.regjeringen.no/nb/dep/kd/dok/veiledninger_brosjyrer/2008/Orientering-om-statsbudsjettet-2009-for-universiteter-og-hoyskoler.html?id=619679
- Ministry of Education and Research:** Orientering om forslag til statsbudsjettet 2010 for universiteter og høyskoler. http://www.regjeringen.no/nb/dep/kd/dok/veiledninger_brosjyrer/2009/statsbudsjettet-2010-orientering-for-uni.html?id=593915
- Ministry of Education and Research:** Orientering om forslag til statsbudsjettet 2011 for universiteter og høyskoler. <http://www.regjeringen.no/upload/KD/Vedlegg/UH/St.prp%201/F-4259BlaattHefteENDELIG.pdf>

Ministry of Education and Research: Press release published on the Ministry of Education and Research's website August 26, 2010. <http://www.regjeringen.no/nb/dep/kd/aktuelt/nyheter/2010/flere-studenter-tar-utdanning-i-utlandet.html?id=613014>

Ministry of Education and Research: Realfag for framtida. Strategi for styrking av realfag og teknologi 2010–2014. <http://www.regjeringen.no/upload/KD/Realfagstrategi.pdf>

Ministry of Education and Research: Report No. 14 (2008–2009) to the Parliament, Internasjonalisering av utdanning. <http://www.regjeringen.no/pages/2152661/PDFS/STM200820090014000DDDPDFS.pdf>

Ministry of Education and Research: Report No. 20 (2004–2005) to the Parliament, Vilje til forskning. <http://www.regjeringen.no/Rpub/STM/20042005/020/PDFS/STM200420050020000DDDPDFS.pdf>

Ministry of Education and Research: Report No. 30 (2008–2009) to the Parliament, Klima for forskning. <http://www.regjeringen.no/pages/2178785/PDFS/STM200820090030000DDDPDFS.pdf>

Ministry of Education and Research: Summary in English: Report No. 14 (2008–2009) to the Parliament, Internationalisation of Education in Norway. http://www.regjeringen.no/pages/2255014/PDFS/STM200820090014000EN_PDFS.pdf

NHO: Horisont 2008. Kunnskap og kompetanse. http://www.nho.no/getfile.php/bilder/RootNY/filer_og_vedlegg1/horisont_1_2008_lav.pdf

Norwegian State Educational Loan Fund: Information concerning extended scholarships and educational loans for studies abroad. <http://www.lanekassen.no/Hovedmeny/Stipend-og-lan/Utland/Hvor-mye/Tilleggsstipend>

Norwegian State Educational Loan Fund: Utenlandsstatistikk. Flere tar full studiegrad i utlandet. http://www.lanekassen.no/Hovedmeny/Om_Lanekassen/Statistikk/utlandsstatistikk/Flere-tar-full-studiegrad-i-utlandet/Statistikk-utland-2008-2009

Risch, T. et al.: Research in Information and Communication Technology in Norwegian Universities and Colleges. A Review. The Research Council of Norway, 2002

ShanghaiRanking Consultancy: Academic Ranking of World Universities (ARWU). <http://www.arwu.org>, 2010

The Norwegian Association of Higher Education Institutions: Rapport om fellesgradssamarbeid og cotutelle, June 2007. http://www.uhr.no/utdanning/utdanningsutvalget/sentrale_dokumenter

Wildavsky, Ben: The Great Brain Race. How Global Universities Are Reshaping the World. Princeton University Press, 2010

