

[ **simula** . research laboratory ]

- by thinking constantly about it





**EDITOR:** PROFESSOR ASLAK TVEITO, MANAGING DIRECTOR, SIMULA RESEARCH LABORATORY

**PROJECT COORDINATOR:** ADVISOR MARIANNE M. SUNDET, SIMULA RESEARCH LABORATORY

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**TRANSLATIONS:** LINDA SIVESIND

**PROOFREADING:** CHRIS WRIGHT

**PHOTO:** SVERRE CHR. JARILD

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## ABOUT SIMULA

Nine years ago, Dag Sjøberg told me that research in software engineering was being held back by the lack of realistic experiments. Typically, experiments would be carried out using students rather than professional system developers; trivial systems would be examined, rather than the huge and complex systems that real-life software development is all about. The programming would be carried out using pencil and paper, and the time-span of an experiment would be counted in hours rather than months.

Dag was convinced that he could do much better, even though leading researchers in the field claimed that realistic experiments were unrealistic! Of course, experiments that are planned and implemented carefully may point the way to a theoretical understanding of software development, and may also reveal inadequacies in current theories. Yet such experiments were considered very hard to put into practice. Today, Dag is the leader of the third most productive software engineering research team in the world, and his team counts outstanding researchers such as Magne Jørgensen and Lionel Briand. Throughout the past nine years, the team has carried out a series of experiments that have yielded a valuable pool of data, paving the ground for a theoretical understanding of how to build reliable and maintainable software at a predictable cost. The team now attracts many visitors and one of them, Professor Barbara A. Kitchenham, wrote a letter to me about her impressions of her visit: "I was extremely impressed with the software engineering research being undertaken at Simula. I do not know of any other research group that has managed to achieve such an excellent combination of methodological rigour and practical relevance. I am convinced that the Simula Laboratory Software Engineering Group is now the benchmark for excellence in empirical software engineering." You will find more about the Software Engineering Department on page 22.

It has been known for centuries that differential equations are well-suited for modelling processes of nature. However, such equations tend to be complex and virtually unsolvable by the classical mathematical tools of paper and pencil. The need to solve such equations was a prime motivation for the

development of electronic computers. In a recent talk, Professor David Keyes argues that both certain numerical algorithms and computer hardware are about 16 million times faster than 60 years ago. The combined progress represents a revolution in our ability to use the computer as a tool for understanding nature. Yet as more complex problems become tractable in terms of computing power, it gradually becomes more difficult to make the transition from mathematical models to software for simulation. This problem has occupied Hans Petter Langtangen for 20 years. Langtangen is internationally renowned as a pioneer in applying modern software development technology to finite-element based simulations. He has recently received grants from the Research Council of Norway to form a Centre of Excellence in biomedical computing at Simula. The Centre was opened in the spring of 2007 and will focus on methods and software for models of biomedical applications. A critical issue for the Centre is the collaboration with medical professionals. This is indeed difficult, because researchers with very different backgrounds will need to be able to communicate well. One such successful collaboration concerns the simulation of blood-flow in the Circle of Willis; see page 20.

In 2004, when Morten Dæhlen was the leader of Simula Innovation, he initiated discussions with the petroleum division of Hydro. Somewhat surprisingly, Hydro was interested in setting up a long-term research partnership with Simula. The idea surprised us partly because Simula had little prior experience in the field and partly because it is generally difficult to attract funding from industry for basic research in Norway. The project has now been running for three years under the superb direction of Are Magnus Bruaset, and StatoilHydro<sup>1</sup> is currently one of Simula's main partners, accounting for more than 10 percent of our income. It has been interesting to observe that the problems addressed by StatoilHydro represent true multidisciplinary challenges, requiring our researchers to utilize

< Professor Aslak Tveito, Managing Director

Simula's competence in software development, simulation, geometric modelling, and visualization. Moreover, StatoilHydro has consistently insisted that Simula should only seek excellent research partners and excellent new employees. In fact, our collaboration with StatoilHydro has clearly increased Simula's attractiveness as a potential employer in the field of computational geosciences. The methods and software developed in the project have already been put into production. As a result of the collaboration in computational geosciences, StatoilHydro also supports the Simula School of Research and Innovation, and is the largest external owner of the company, followed by Bærum Municipality, Telenor, Sintef, and the Norwegian Computing Centre. Recent negotiations with StatoilHydro revealed that the merging of Statoil and Hydro has significantly increased their interest in basic research. Simula expects StatoilHydro to be our second most important partner for many years to come. The Norwegian Government will always, both in terms of ownership and funding, be Simula's most important partner.

Ever since computers first began to be used, researchers have tried to facilitate efficient communications between them. Tools for exchanging files and messages from computers around the world were available amongst researchers in the 1970s and e-mail became widespread at universities during the 1980s. In the mid-1990s, Internet browsers became publicly available and the use of the internet started to grow exponentially. The growth, both in the flow of information and demands for real-time applications, poses difficult problems for researchers in communication technology. One particular challenge is to develop networks that maintain an acceptable level of service in the face of challenges to normal operation. Olav Lysne told me four years ago that he and his co-workers had ideas for novel algorithms that would enable a network to recover much more quickly from component failure. We addressed the Ministry of Transport and Communication and they liked the sound of our ideas and provided funding for further research. At the time of writing, the research group is preparing a demonstration of its technology for the Minister of Transport and Communications. A common network delay of 30 seconds has been reduced to a fraction of a second; see page 18 for more information.

Augustus Waller was a pioneer of electrophysiology.

Over 100 years ago, he realized that the electrical activity of the heart could be examined by performing measurements on the surface of the body. His work was improved upon considerably by Wilhelm Einthoven, who was able to link measurements on the body surface to possible disorders of the heart. Nowadays, electrocardiograms (ECGs) are used routinely to uncover various kinds of damage to the heart muscle. These measurements are based on the electrical activity that arises in the Sinoatrial node and flows throughout the heart all the way to the surface of the body. It is well-known that this process can be modelled fairly accurately using mathematical tools and it is also known that if these models could be inverted, we would be able to infer the characteristics of the heart by analyzing the measurements on the body surface. At present, this technology can only provide very general information about the heart. Equipped with a well-developed toolbox of mathematics and software, Bjørn Fredrik Nielsen and his colleagues have attacked this problem and concentrated all their efforts on trying to develop mathematical methods and computer software that can reveal the size and the location of ischemia, which is a precursor of a myocardial infarction. At the time of writing, they have started to receive real-world data from their collaborators at the Rikshospitalet University Hospital.

The projects described in brief above are the signature of Simula. They illustrate the way we work and the way we are going to work in the future. We identify grand scientific challenges, solutions for which would be of genuine value for society. We then work on them for a long time. Throughout each project we publish our findings, educate PhD students, and seek commercial applications. Yet from the beginning to the end, the most important issue is to generate new understanding of important problems. This is what Simula is all about.

<sup>1</sup> Statoil and Hydro's petroleum operations merged in 2007.

## AN EXPANSIVE YEAR

In 2007, Simula Research Laboratory (Simula) completed the establishment of several major ventures and continued expansions adopted in 2006. The expansions called for a great deal of extra administrative work in 2007, at the same time as the Centre maintained a burgeoning level of activity related to research, education and innovation.

Simula founded its first subsidiary, Simula Innovation AS, in 2004. It subsequently set up the subsidiary Kalkulo AS in 2006, while the third subsidiary fell into place with the establishment of the Simula School of Research and Innovation at the University of Oslo in 2007. The Simula Group has thereby progressed from being a dedicated research centre upon its establishment in 2001 into a research corporation with 114 employees year-end 2007. Simula is located at IT-Fornebu, Bærum Municipality.

### Recognition for research

Simula maintained and consolidated its high level of research activities in 2007. The Centre's Scientific Advisory Board (SAB) undertook a thorough review of Simula in its entirety in June. The SAB reports are generally very favourable to the development of Simula as a whole and to its individual units. The general message is that Simula merits praise for having achieved a strong scientific position in a very short time, and that its development is highly favourable also in the fields of education and innovation.

SAB draws particular attention to the exceptionally positive trend achieved by Networks and Distributed Systems Department (ND). The Scientific Computing Department (SC) had already been characterised as 'excellent' by the evaluation in 2004. According to SAB, it has made further advances since then. The Software Engineering Department (SE) was also highly commended.

A total of six doctorates were completed at Simula in collaboration with University of Oslo in 2007. The number of scientific publications emanating from Simula remains at a high level.

In December 2006, the Research Council of Norway announced the allocation of a total of MNOK 75 over a 10-year period to a Centre of Excellence (CoE) at Simula. The new CoE, the Center for Biomedical Computing (CBC), has its roots in the SC Department and was established in 2007. The CoE will accommodate world-class research in the calculation and simulation of fluid flows, specifically the blood flow through the aorta.

The establishment of CBC and the Simula School are the most important reasons why the Simula Group expanded its staff significantly in 2007 from 85 full- and part-time employees at the end of 2006 to 114 a year later. The expansion also engendered a need for more office space and meeting rooms, a problem that was solved by expanding the lease with the property owner, IT Fornebu Eiendom AS.

The Board has noted that the September issue of the highly respected *Journal of Systems and Software* rated Professor Magne Jørgensen as the most prolific individual researcher in the world in terms of scientific production among scientists engaged in the development of IT systems.<sup>1</sup> Meanwhile, the SE Department rated third in the ranking of the world's leading research groups in the field. The rating encompasses 361 research groups and 3 918 researchers.

- > Simula's Board of Directors and Administration. From left: Mads Lundqvist, Åshild Grønstad Solheim, Harald Holm-Simonsen, Ingvild Myhre (Chair of the Board), Ottar Hovind, Anne-Brit Kolstø, Aslak Tveito, Wenche Angel and Gunnar Hartvigen. Hilde Tonne and Bjørn Fredrik Nielsen were not present when the picture was taken.



During the year, Simula recruited the internationally renowned French researcher Professor Lionel Briand, whose previous merits include the establishment of a laboratory for Software Quality Engineering at Carleton University in Ottawa.

#### Research and ethics

On 1 January 2007, Simula introduced new regulations for scientific publications based on the Vancouver Convention's best practice guidelines on publication ethics. The regulations state inter alia that all co-authors are to check to ensure that the script is in accordance with the convention, and that all sets of data should be checked by at least two researchers. Simula's experience in 2007 has been excellent.

#### Society and dialogue

The Research Council has introduced a trial scheme involving regular dialogue meetings with companies in which the State owns a significant interest. In November, Simula's Board and administration met with representatives of the Ministry of Research for a good, productive dialogue on items of central importance to Simula's operations.

Once again in 2007, Simula was met by very favourable attitudes on the part of private and public players in Bærum Municipality. Among other things, the municipality has a substantial stake in the Simula School.

In February 2007, Simula was named 2006 Company of the Year in Bærum. The jury consisted of representatives for Nordea Bank Norge ASA, Bærum Næringsråd, Budstikka Media and Bærum Municipality. The jury's grounds stated that Simula is becoming a catalyst in the Fornebu community, and that the Centre has carved out a position as a dynamic research institution with a culture and results that attract international recognition.

During the year, Simula joined Bærum Næringsråd, a network and meeting place for business and industrial activities in the municipality.

#### The Simula School

Simula's third subsidiary, the Simula School of Research and Innovation AS (the Simula School), was formally founded on 8 May 2007. The Simula School is intended to educate master's and doctoral students in areas of relevance to business and industry in close cooperation with several industrial players and the University of Oslo (UiO), which will formally confer the degrees.

In December 2006, it became clear that the Ministry of Education and Research would allocate MNOK 5 for the establishment of a school for research at Simula. Simula was then free to invite industrial players to buy shares in the company. The result was the establishment of a joint venture between Simula (56 per cent of the shares), StatoilHydro (21 per cent), Bærum Municipality (14 per cent), Telenor (7 per cent), SINTEF (1 per cent) and the Norwegian Computing Centre (1 per cent).

The official opening of the Simula School took place on 20 August and was attended by State Secretary Rikke Lind from the Ministry of Trade and Industry and many representatives of Simula's partners.

The establishment of the Simula School means that Simula is well equipped to expand its PhD programmes in terms of both quality and quantity. The focus was on recruitment and further development during the school's first year. Since year-end 2007, all employees in positions as research trainees, PhD positions and postdoctoral fellows at the parent company have been transferred to the Simula School, bringing the school's staff to 31 employees (21 men and 9 women).



The Simula School attaches importance to recruiting women in traditionally male-dominated disciplines. For that reason, it is involved in the project 'Girls, science and management' being run by Valler Upper Secondary School. This programme will pave the way for similar initiatives at other upper secondary schools.

### Simula Innovation

Simula Innovation AS has been characterised by bustling activity as well as staff expansion and commercialisations in 2007. Supported by the FORNY programme under the auspices of the Research Council of Norway, the Resilient Routing project was completed during the year with good results. Simula Innovation was also granted FORNY support for three new projects: Lividi, which involves scalable video coding; ECG Analyzer, which is to verify a technology to diagnose possible infarctions or cardiac ischemia; and Applied Knowledge, which is developing a technology that can be used for recruitment and management purposes in connection with in-depth testing of IT developers.

Simula's T2M commercialisation tool was developed by Simula Innovation AS in 2005. The tool was further developed in 2006, and in 2007, the company entered into partnership with an important Nordic player when the Nordic Innovation Centre (NICe) decided to support the project further. NICe is the Nordic Council of Minister's instrument for promoting innovative, knowledge-intensive Nordic industry. The support will be used to set up the Nordic countries' first knowledge centre for the commercialisation of research results and ideas that emanate from research institutions and industry.

Simula Innovation organised a special Innovation Day in 2007, including an innovation competition that elicited 15 exciting suggestions. Further work has been done on several of these proposals in 2008.

In 2006, the company established an innovation prize which was awarded for the second time in 2007. The prize goes to the Simula researcher or project that has come furthest with commercialisation. In 2007, the prize went to World Beside (see the section on Kalkulo).

### Kalkulo AS

Financially speaking, 2007 was a good year for Kalkulo AS, which showed a strong positive result on

its balance sheet. Established in 2006, Kalkulo supplies technical software based on mathematics, geometry and visualisation.

During the year under review, the company played an important role in a joint project with the Norsk Hydro corporation on Computational Geosciences (CG). The project's goal is to develop a better understanding of the geological and geophysical processes that play a part in the development of hydrocarbon deposits. The contracts were transferred to StatoilHydro from 1 October 2007 following the merger between Statoil and Norsk Hydro's oil and gas activities. Kalkulo has also been an important contributor to the ECG Analyzer project.

During the year, a considerable portion of Kalkulo AS was transferred to the company World Beside AS in which Simula Innovation has a significant stake, along with the University of Oslo. World Beside AS is engaged in developing a three-dimensional game-based learning environment for use in upper secondary school. Content in the form of installations is the main learning tool. The transfer took place on commercial terms to optimise focus on the enterprise.

### Environmental issues

Simula's activities do not pollute the outdoor environment. Simula purchased pollution credits to compensate for its business flights in 2007.

### Hiring, equal opportunity and integration

At the end of 2007, Simula had 69 full-time employees. Four of these are affiliated with Norwegian Universities but use Simula as their primary workspace. Simula also had 15 part-time employees, bringing total staff to 84 individuals. Of the 69 full-time employees, there were 53 men and 16 women, and 18 were foreign nationals.

The Simula Group had a total of 114 employees in both full-time and part-time positions at year-end 2007. Of the 114, there were 93 men and 21 women, and 28 were foreign nationals.

Simula aspires to raise the percentage of women on staff. Simula and the Group's subsidiaries strive to comply with political signals recommending at least 40 per cent of each gender on their boards of directors.



Simula attaches great importance to integration. In 2007, for the first time, the centre organised a language course for foreign employees and their spouses/life partners. The initiative was very well received. One effective integration initiative is that all researchers work on projects in cooperation with colleagues, making daily contact essential.

Right from the start, Simula has attracted foreign researchers, but this reached new heights in 2007 in connection with rapid staff expansion. For example, there were more than 100 applicants, including many from Pakistan, for a fellowship announced jointly with Telenor. About 55 per cent of the new staff members in positions as research trainees, PhD students, post-doctoral fellows and research scientists hired in 2007 came from abroad.

It is the Board's impression that Simula employees have a high level of job satisfaction, and that this is an instrumental factor in the good results achieved in 2007.

Absence due to illness is very low in Simula as well as in the Simula Group. No work-related illnesses or accidents were reported during the year.

#### Financial affairs

Simula's aggregate operating revenues came to MNOK 69.2 in 2007. External project financing totalled MNOK 20.2. The net profit for the year was NOK 231 675, which was transferred to equity.

The Simula Group's aggregate operating revenues totalled MNOK 91.1, and the net profit of the year came to MNOK 4.2 after minority interests.

The Simula School of Research and Innovation AS was founded 8 May 2007. The aggregate operating revenues came to MNOK 6.3, and the net profit for 2007 came to MNOK 2.2.

For 2007, sales for Kalkulo AS totalled MNOK 8.3, and the profit after tax was MNOK 1.9.

The aggregate operating revenues for Simula Innovation AS came to MNOK 18.8, and the net profit for 2007 came to NOK 860 407.

Pursuant to an agreement with the Research Council of Norway, Simula received a basic subsidy of MNOK

49 in 2007. In the State Ownership Report 2006, Simula received positive signals about continued subsidies up until 2015, provided it receives a favourable evaluation in 2009. The Research Council will also be allocating a total of MNOK 75 to CBC over the next decade. Further, the Ministry of Transport and Communications has pledged funding for the Resilient Networks project for a five-year period, i.e. an allocation of MNOK 5 in 2007, then MNOK 6 in 2008 and the two subsequent years.

In 2007, the Simula School concluded an MNOK 18 framework agreement with StatoilHydro which will run until 2010. Kalkulo AS has an ongoing cooperative project with StatoilHydro on Computational Geosciences.

The going concern assumption applies and is the basis for the annual accounts. The company has a sound operating structure. No situation has arisen since year end 2007 that has had a material impact on the accounts as presented.

#### Outlook

The Board confirms that 2007 was a year featuring important new ventures and expansion. Simula continues to achieve good research results, and the establishment of CBC was a major milestone for the centre. The subsidiaries Simula Innovation and Kalkulo have picked up momentum, and their efforts to innovate and commercialise research results provide a good platform for further development. The establishment of the Simula School contributes to the education of highly qualified researchers in the field of ICT and paves the way for Simula to produce more graduates whose services will be sought-after by the academic world as well as business and industry. Simula emerged from 2007 in a stronger position both academically and financially, and it will be a high-priority task to strengthen this platform further in 2008.

<sup>1</sup> *The Journal of Systems and Software* is available at [http://www.elsevier.com/wps/find/journaldescription.cws\\_home/505732/description#description](http://www.elsevier.com/wps/find/journaldescription.cws_home/505732/description#description)

The press release from Simula about the rating is available at <http://simula.no/pressreleases/norsk-forsker-best-i-verden/>.

## FINANCIAL STATEMENT

2006		2007		INCOME STATEMENT		2007		2006	
GROUP				Note	PARENT COMPANY				
69 778 726	91 183 153	OPERATING REVENUES		6	69 234 480	64 205 455			
		OPERATING EXPENSES							
42 832 648	57 127 339	Cost of labour		5	45 199 347	38 162 571			
1 871 405	1 692 578	Ordinary depreciation		3	1 647 718	1 859 946			
21 538 852	26 957 815	Other operating expenses		5	22 822 645	21 723 039			
66 242 905	85 777 732	TOTAL OPERATING EXPENSES			69 669 710	61 745 556			
3 535 821	5 405 421	OPERATING PROFIT			-435 230	2 459 899			
		FINANCIAL ITEMS							
313 359	834 921	Other interest income			671 682	319 197			
1 587	35 346	Other financial income			9 141	671			
11 299	5 360	Other interest expenses			1 431	6 442			
1 981	241 764	Other financial expenses			12 487	1 608			
301 666	623 143	RESULT OF FINANCIAL ITEMS			666 905	311 818			
3 837 487	6 028 564	PROFIT BEFORE TAXES			231 675	2 771 717			
164 953	759 360	TAXES FOR THE YEAR			-	-			
3 672 534	5 269 204	NET PROFIT			231 675	2 771 717			
0	1 006 586	Minority Interests			0	0			
3 672 534	4 262 618	RESULTS AFTER MINORITY INTERESTS			231 675	2 771 717			
		TRANSFERS							
		Transferred to equity			231 675	2 771 717			
					231 675	2 771 717			

2006	2007	BALANCE SHEET		2007	2006
GROUP			Note	PARENT COMPANY	
		TANGIBLE FIXED ASSETS			
		Fixed assets			
2 890 701	3 692 547	Furniture, equipment, etc.	3	3 651 731	2 861 591
2 890 701	3 692 547	Total fixed assets		3 651 731	2 861 591
		Financial fixed assets			
1 396 968	1 205 972	Investments in shares	12	-	-
-	-	Intra-Group loans	11	300 000	600 000
-	-	Investments in subsidiaries	10	5 319 700	4 762 300
1 396 968	1 205 972	Total financial fixed assets		5 619 700	5 362 300
4 287 669	4 898 519	TOTAL FIXED ASSETS		9 271 431	8 223 891
		CURRENT ASSETS			
		Receiveables			
3 733 453	7 579 359	Accounts receivable		4 377 773	2 404 818
4 214 670	6 863 615	Other receiveables		4 162 177	4 420 239
7 948 123	14 442 974	Total receiveables		8 539 950	6 825 057
6 513 720	15 262 989	Bank deposits	9	5 088 565	4 162 598
14 461 843	29 705 963	TOTAL CURRENT ASSETS		13 628 515	10 987 655
18 749 512	34 604 482	TOTAL ASSETS		22 899 946	19 211 546
		EQUITY			
		Paid-in equity			
1 500 000	1 500 000	Share capital	7,8	1 500 000	1 500 000
1 500 000	1 500 000	Total paid-in capital		1 500 000	1 500 000
		Earned equity			
4 177 227	9 838 013	Other equity	8	6 488 301	6 256 626
0	2 559 393	Minority Interests	8	0	0
4 177 227	12 397 406	Total earned equity		6 488 301	6 256 626
5 677 227	13 897 406	TOTAL EQUITY		7 988 301	7 756 626
		LIABILITIES			
		Short-term liabilities			
4 692 421	5 743 936	Accounts payable		4 666 313	4 242 996
164 953	759 360	Tax payable	13	0	0
3 466 089	5 710 392	Duties payable		3 795 185	2 999 132
4 748 822	8 493 388	Other short-term liabilities		6 450 147	4 212 792
13 072 285	20 707 076	Total short-term liabilities		14 911 645	11 454 920
13 072 285	20 707 076	TOTAL LIABILITIES		14 911 645	11 454 920
18 749 512	34 604 482	TOTAL EQUITY AND LIABILITIES		22 899 946	19 211 546

## NOTES TO THE ACCOUNTS

### Note 1 – Accounting principles

The financial statements have been prepared pursuant to the regulations in the Norwegian Accounting Act of 1998. The statements have been drawn up in accordance with Norwegian accounting standards.

#### The main rule for the valuation and classification of assets and liabilities

Assets intended for permanent ownership or use are classified as tangible fixed assets. Other assets are classified as current assets. Receivables to be paid back within one year are always classified as current assets. The same criteria are applied to the classification of short- and long-term liabilities.

Fixed assets are valued at acquisition cost, but written down to their fair value if the reduction in value is believed to be of a permanent nature. Fixed assets are depreciated systematically over the useful life of the asset. Long-term liabilities are recognised at their nominal values on the date the debt was incurred. Long-term liabilities are not revalued to fair value in response to interest rate fluctuations.

Current assets are valued at cost or fair value, whichever is lower. Current liabilities are recognised at their nominal values on the date the debts were incurred. Current liabilities are not revalued to fair values in response to interest rate fluctuations.

Certain items are valued according to other rules, as explained below.

### Note 3 – Fixed assets

#### Simula Research Laboratory AS

	Computer equipment	Furniture/fittings, equipment, etc.	Total
Acquisition cost at 1 Jan.	4 878 873	5 434 924	10 313 797
Acquired 2007	767 799	1 706 684	2 474 483
Disposals 2007	967 424	37 243	1 004 667
Acquisition cost at 31 Dec.	4 679 248	7 104 365	11 783 613
Acc. depreciation	3 367 353	4 764 529	8 131 882
Book value at 31 Dec.	1 311 895	2 339 836	3 651 731
Ordinary depreciation	756 701	891 017	1 647 718
Depreciation in %	20–50%	20–33%	

### Foreign currencies

Assets and liabilities in foreign currencies are translated into Norwegian kroner at the mid-rates quoted by Norges Bank on the day of balance sheet recognition.

### Tangible fixed assets

Tangible fixed assets are generally depreciated over the expected useful life of the asset. Depreciation is generally distributed on a straight line basis over the expected useful life of the asset.

### Receivables

Accounts receivable and other receivables are recorded at nominal amounts less provisions for anticipated losses on bad debts. Provisions for losses are based on individual assessments of the recoverability of each receivable. In addition, if necessary, a general provision is made for anticipated bad debts on other receivables.

### Pensions

A straight line earning profile is used to account for pensions and assumptions are made regarding expected salary upon retirement.

### Taxes

The company has no tax expenses since its activities are not considered taxable.

### Note 2 – Financial market risk

The company has little exposure to financial market risk.

## Simula Research Laboratory AS – Group

	Computer equipment	Furniture/fitings, equipment, etc.	Total
Acquisition cost at 1 Jan.	4 901 442	5 434 924	10 336 366
Acquisitions 2007	822 374	1 706 684	2 529 058
Disposals 2007	988 464	37 243	1 025 707
Acquisition cost at 31 Dec.	4 735 352	7 104 365	11 839 717
Acc. depreciation	3 382 641	4 764 529	8 147 170
Book value at 31 Dec.	1 352 711	2 339 836	3 692 547
Ordinary depreciation	801 561	891 017	1 692 578
Depreciation in %	20–50%	20–33%	

### Note 4 – Pension costs

The Group has a pension plan that covers a total of 64 individuals in the parent company and 91 individuals in the Group. The pension plan provides defined future benefits. Pension benefits depend on the individual employee's number of years of service, salary level upon retirement age, and social security benefits. The collective pension agreement is funded by building up pension funds under the auspices of the Norwegian Public Service Pension Fund.

### Note 5 – Cost of labour, number of employees, remuneration, etc.

Cost of labour	Simula Research Laboratory AS		Simula Research Laboratory AS Group	
	2006	2007	2006	2007
Wages	30 404 601	35 723 927	34 256 693	45 451 230
National insurance payment	4 594 499	5 462 471	5 168 333	6 910 740
Pension expenses	2 046 525	1 810 743	2 277 820	2 446 888
Other benefits	1 116 946	2 202 206	1 129 802	2 318 480
<b>Total</b>	<b>38 162 571</b>	<b>45 199 347</b>	<b>42 832 648</b>	<b>57 127 339</b>
Average man-years of labour	60	65	66	81

Benefits to top management		
	Simula Research Laboratory AS	Simula Research Laboratory AS Group
Director	1 077 517	-
Other remuneration	386 197	-
Pension expenses, director	48 893	-
The Board of Directors	176 000	289 400
Auditor	48 200	83 900
Others auditing services	39 400	58 900

## Note 6 – Operating revenue

	Simula Research Laboratory AS	Simula Research Laboratory AS Group
Research funding	49 000 000	55 000 000
Subsidies from the Research Council of Norway and the EU	13 264 360	18 282 448
Services for the subsidiary	5 017 341	-
Subsidies for research fellows	1 841 575	1 841 575
Other income	102 840	16 059 130

## Note 7 – Share capital and ownership structure

The company's share capital consists of 1 000 shares with a nominal value of NOK 1 500 per share.

The shares are owned by:

The Norwegian state /repr. by the Ministry of Education and Research	80%
The Norwegian Computing Centre	10%
Sinvent AS	10%

## Note 8 – Equity

Simula Research Laboratory AS

	Share capital	Other equity	Total equity
Equity at 1 Jan.	1 500 000	6 256 626	7 756 626
Net profit for the year	-	231 675	231 675
Equity at 31 Dec.	1 500 000	6 488 301	7 988 301

Simula Research Laboratory AS - Group

	Share capital	Other equity	Minority Interests	Total equity
Equity at 1 Jan.	1 500 000	4 177 229	-	5 677 229
Contributed equity	-	1 398 168	1 552 807	2 950 975
Net profit for the year	-	4 262 618	1 006 586	5 269 204
Equity at 31 Dec.	1 500 000	9 838 013	2 559 393	13 897 406

Contributed equity applies to the subsidiary Simula School of Research and Innovation AS (SSRI AS), where the minority subscribed at a premium and Simula Research Laboratory AS subscribed at par value.

## Note 9 – Bank deposits

The company had locked-in bank deposits of NOK 1 779 552 in connection with signed leases and NOK 2 114 988 in restricted deposits relating to withholding taxes. The Group's tied-up withholding tax aggregated NOK 2 819 429.

## Note 10 – Subsidiaries

	Main office	Stake at 31 Dec.	Book Value	The company's equity at 31 Dec.	The company's profit/loss 2007
Simula Innovation AS	Fornebu	100 %	4 356 300	2 713 144	860 407
Kalkulo AS	Fornebu	100 %	406 000	2 733 030	1 902 866
SSRI AS	Fornebu	55.74%	557 400	5 782 631	2 274 256

## Note 11 – Outstanding accounts/intra-Group transactions

	2006	2007
Claims against Simula Innovation AS	2 108 005	2 560 952
Debt to Simula Innovation AS	-	30 578
Long-term claims against Kalkulo AS	600 000	300 000
Short-term claims against Kalkulo AS	181 268	403 761
Debt to Kalkulo AS	197 348	-
Claims against SSRI AS	-	388 345
Debt to SSRI AS	-	254 540
Subidies to Simula Innovation AS	2 300 000	2 700 000
Sale of services etc. to Simula Innovation AS	4 537 460	5 526 858
Sale of services etc. to Kalkulo AS	- 25 653	606 038
Sale of services etc. to SSRI AS	-	444 843
Interest income from Kalkulo AS	-	14 250

## Note 12 – Shares

	Number	Nominal value per share	Book Value
Silent Wings AS	3 250	10.00	34 548
Project Economics AS	1 050	33.34	36 273
Vpos AS	1 030	100.00	1
World Besides AS	40 000	1.00	40 000
Symphonical AS	545 528	0.10	1 095 150
			1 205 972

**Note 13 – Tax**

Simula Research Laboratory AS does not engage in taxable activities. The subsidiary Simula School of Research and Innovation AS does not engage in taxable activities. The subsidiaries Simula Innovation AS and Kalkulo AS are liable to taxation. Simula Innovation AS carried forward a deficit of NOK 2 588 291,-.

**Taxation for the year consists of:**

Tax payable	<u>759 360</u>
<b>Net total taxes</b>	<u><b>759 360</b></u>

**Tax payable for the year is calculated as follows:**

Earnings before tax (EBT) – Kalkulo AS	2 662 226
Permanent differences	3 471
Change in temporary differences	<u>46 304</u>
Base tax payable	<u>2 712 001</u>
<b>Tax payable on the profit for the year</b>	<u><b>759 360</b></u>



## CASH FLOW STATEMENT

Simula Research Laboratory AS Group			Simula Research Laboratory AS	
2006	2007		2007	2006
		Cash flow from operating activities:		
3 672 534	5 269 204	Net profit for the year	231 675	2 771 717
1 871 405	1 692 578	Depreciation expense	1 647 718	1 859 946
-	205 999	Write downs on share investments	-	-
-2 998 373	- 6 494 851	Change in receivables	-1 714 891	- 2 768 474
1 346 356	7 634 791	Change in short-term liabilities	3 456 724	1 413 837
3 891 922	8 307 721	Net cash flow from operating activities	3 621 226	3 277 026
		Cash flow from investing activities:		
-1 392 915	- 2 494 424	Investments in production equipment, net	-2 437 858	- 1 370 347
-1 135 150	- 15 003	Investments in shares	-557 400	- 406 000
-2 528 065	- 2 509 427	Net cash flow from investing activities	-2 995 258	- 1 776 347
		Cash flow from financing activities:		
-	2 950 975	Contributed equity	-	-
-	-	Change, long-term receivables	300 000	- 600 000
-	2 950 975	Net cash flow from financing activities	300 000	- 600 000
1 363 857	8 749 269	Net cash flow for the period	925 967	900 679
5 149 863	6 513 720	Cash reserves, 1 January	4 162 598	3 261 919
6 513 720	15 262 989	Cash reserves, 31 December	5 088 565	4 162 598

## THE NETWORKS AND DISTRIBUTED SYSTEMS DEPARTMENT

### “ A Multinational Work Environment

High on the wish list of any research unit is the ability to attract the most talented employees from anywhere in the world. This is particularly important for Norway, given that the Norwegian population is so small. Until quite recently, the Networks and Distributed Systems Department mainly recruited researchers nationally. This has changed over the past two years. In 2007, we appointed six new people, four of whom were recruited from outside Norway.

The contributions of these people represent enrichments on many levels. The most important contributions from a scientific point of view are that each of them brings in new expertise and a new set of scientific contacts. Such inputs are of huge value to an environment like ours, and we expect that they will lead to new and fruitful research paths as well as new and fruitful collaborative relations.



The impact of different nationalities is also visible at the level of project leaders. In the annual report of 2006, Carsten Griwodz presented his research project on Resource Usage in Distributed Applications. This year, Yan Zhang describes his recently initiated project on Resilient Wireless Networks. These are both projects that have shown significant results and have even more significant potential for the future.

”

### Providing Resilient Services in Wireless Communications

Wireless communications has experienced a recent explosion of development, with significant increases in the number of mobile terminals (mobile phones, laptops, BlackBerrys, PDAs etc.) Corresponding to this trend, it has become a basic requirement to be able to access enterprise networks and the Internet anytime and anywhere. Different from traditional telecommunication networks, wireless networks have limited bandwidth, unreliable wireless channels, insecure radio interfaces, and limited power. Due to these disadvantages, wireless services are often unstable, of low quality, or even experience undesirable forced termination. We call such phenomena a ‘lack of resilience’ to tolerating faults and to providing guaranteed Quality-of-Service (QoS). In both academia and industry, providing resilience capability in wireless networks is far from maturity.

The goal of the Networks and Distributed Systems Department’s project “Resilient Wireless Networks” (RWN) is to provide resilient services continuously and effectively for wireless networks. This has instant appeal to mobile service providers, wireless system operators, and manufacturers of telecommunication equipment. The chief scientific motivation is the design of resilient, efficient, distributed, and scalable protocols. In wireless networks with mobile users, distributed algorithms have compelling characteristics, e.g. lower overhead and higher efficiency. We are expecting to incorporate resilience as an inherent capability for services in wireless communications. The resilience context, including property, mechanism, and solutions, will play a significant role in the provision of mobile services. Integrated resilience and a QoS framework are envisioned to provide an new efficient perspective on wireless networks development. This is capable of supporting QoS, reliability, and robustness.

< Olav Lysne, Head of Department, Networks and Distributed Systems.

In 2007, RWN focused on the emerging wireless technologies WiMAX, wireless sensor networks, and wireless mesh networks. In these networks, RWN addressed issues of resilience with respect to energy management, resource management, and mobility management.

- Wireless Sensor Networks (WSNs) represents a highly promising technology with wide applications, e.g. environment and habitat monitoring, healthcare applications, battlefield surveillance, and traffic control. In WSNs, sensor nodes are usually unattended, resource-constrained, and unchargeable. Hence, efficient utilization of the limited energy is the most important concern in providing resilience in sensor networks. We propose an energy-efficient and QoS-aware real-time packet forwarding scheme with the aim of minimizing energy consumption subject to an end-to-end delay requirement. The adaptive transmission rate, energy efficiency, and routing decision are taken into account simultaneously. The results of our efforts indicate significantly conserved energy consumption with guaranteed delay requirement. This mechanism is particularly useful for real-time monitoring in unattended areas, which is one of the main applications of sensor networks.

- WiMAX is regarded as the next-generation wireless access technology. In WiMAX, mobile terminals are powered by a rechargeable battery. As a consequence, using the limited recharged energy and hence lengthening a mobile terminal's working lifetime is an important problem in providing resilience for mobile terminals. We propose an effective energy management scheme by adaptively adjusting the sleeping window to substantially reduce energy consumption in mobile terminals.

- Multimedia (e.g. voice, Internet, video, and TV) will increasingly be supported in wireless communications. This leads to the problem that different services may require different levels of resilience. In wireless mesh networks, we propose an efficient QoS prioritization to offer different classes of service resilience. This scheme is further applied in WiMAX mesh networking.

- Orthogonal Frequency-Division Multiplexing (OFDM) is a digital multicarrier modulation scheme in which a signal is partitioned into several subchannels at different frequencies. OFDM-based systems are able to deliver a high data rate, achieve high spectral efficiency, operate in the hostile multipath radio environment, and reduce power consumption. Given these advantages, OFDM is becoming a fundamental technology in wire-

less communications and is now used in WiFi and WiMAX standards. For OFDM-based systems, we propose an efficient policy for controlling the admission of calls. The strategy will make an intelligent decision to either accept or deny a call request. It has been shown that the scheme is able to substantially enhance network throughput and increase service reliability.

- Theoretical study is an indispensable part in this project to understand resilience. In infrastructure-based wireless networks (e.g. GSM), a system analytical framework has been presented that takes into account a number of factors that lead to network/service unreliability, e.g. an unreliable wireless channel and limited bandwidth in the radio interface. This framework will provide an efficient tool for the tuning of performance in wireless networks.

- The most visible contribution is the investigation of the relationship between mobility and QoS. The methodology and results provide a unique viewpoint from which to study resilience, mobility, QoS, and their relationship. For this novel contribution, we received the best paper award at the IEEE AINA-07 conference.

The problems that we identified above, and the solutions that we have proposed, have been accepted by the research community and have been published in high-ranking journals (e.g. IEEE Transactions or magazines) and in the proceedings of prestigious international conferences. In summary, in 2007, we have proposed innovative solutions to a number of issues pertaining to resilience in wireless communications, using theoretical modelling and verification by simulation. The solutions are able to significantly enhance network/service resilience, either directly on the resilience itself or indirectly on issues closely related to resilience.

In 2008, we will continue to improve resilience in wireless systems. We will place greater emphasis on the optimal and systematical perspectives. We will rely heavily on queuing theory, optimization, and game theory to increase system resilience and QoS in cognitive mesh networks, sensor networks, and WiMAX with respect to energy, resource, mobility, spectrum, and data management.

## THE SCIENTIFIC COMPUTING DEPARTMENT

The Scientific Computing Department specialises in numerical methods and developing reliable and efficient software for solving partial differential equations (PDEs). During the past few years, our research has been geared towards developing and combining generic models and software for applications in medicine and geoscience.

The department set up the Norwegian Centre of Excellence, *Center for Biomedical Computing* (CBC), in April 2007. The goal of the centre is to facilitate access to complex mathematical models for scientists, the primary area of application being biomedicine and fluid flows. The research is oriented towards three main research areas: scientific software (Computational Middleware), numerical methods (Robust Flow Solvers), and medicine (Biomedical Applications). From 1 September, 2007, the centre was extended to include our ongoing medically-oriented projects: Cardiac Computations and Inverse Problems.

The purpose of the Computational Middleware project is to develop a useful, Matlab-like set of tools that computational scientists can use for the rapid prototyping of simulation software for multi-physics problems described by PDEs.

The goal of the Robust Flow Solvers project is to advance the computational middleware tools in the specific direction of robust adaptive implicit finite element methods for viscous and turbulent fluid flow. In the Biomedical Applications project,

we want to apply the simulation tools from the Computational Middleware and the Robust Flow Solvers projects, in conjunction with commercial software, to address challenging biomedical flow problems. Many new subprojects within the above mentioned three main projects were started in 2007. Most of this research is carried out in close collaboration with leading national and international scientists, and we have found that the CBC attracts significant attention from researchers outside Simula. Although the centre is still in the start-up phase, many encouraging scientific results have been achieved.

In 2007, the members of the Inverse Problems (IP) project focused on improving their mathematical, computational, and biological insight, and performed simulations with synthetic data. Furthermore, the collaboration with Rikshospitalet HF was intensified, and the testing of the computational schemes on real world data was begun. This task involves recording ECG measurements and geometrical data from a number of patients, and then checking whether the computational algorithms are able to determine the correct size and location of the ischemic region. Aside from this scientific progress, the IP project also published an article in the *Zurich Intelligencer* at the International Congress on Industrial and Applied Mathematics (ICIAM). This congress is the largest and leading conference for applied and industrial mathematics. It features more than 3000 participants, each of whom receives a copy of the *Zurich Intelligencer*. Attention of this magnitude is rare for scientific computing researchers. Bjørn Fredrik Nielsen, the leader of the Inverse Problems project, received the Simula Research Award in December 2007.



< Hans Petter Langtangen,  
Head of Department, Scientific Computing.

The members of the Cardiac Computing (CC) project have worked on tightening their bonds to international groups, including participation in three different proposals for the EU's 7th Framework Programme. Although the outcome of these proposals is still not known, the work in the project consortia has led to several new connections with international research groups, as well as to the strengthening of existing connections. The publication list of the CC group showed a steep increase from 2006 to 2007, and includes publications in the high impact journals *Stroke* and *Biophysical Journal*.

The Computational Geosciences project has maintained its focus on contributions to technologies that are vital to StatoilHydro's exploration and production activities. In particular, this concerns time-dependent, multi-resolution, multi-layered tectonic modelling and the construction of editable geological models for complicated 3D structures. The latter activity has contributed to the planning of tail production on the Troll field and to several other applications. We have also addressed new topics. In this context, we have made successful studies of approaches to the handling of uncertainty in the description of mathematical models for geological processes. The current study has looked at diffusion-driven models for submarine deposition and has handled the uncertainty in lithology-dependent diffusion parameters in two different ways. This is done stochastically, through the use of the Probabilistic Collocation Method, or through the identification of PDE-based parameters using an inverse problem approach.

### The Circle of Willis

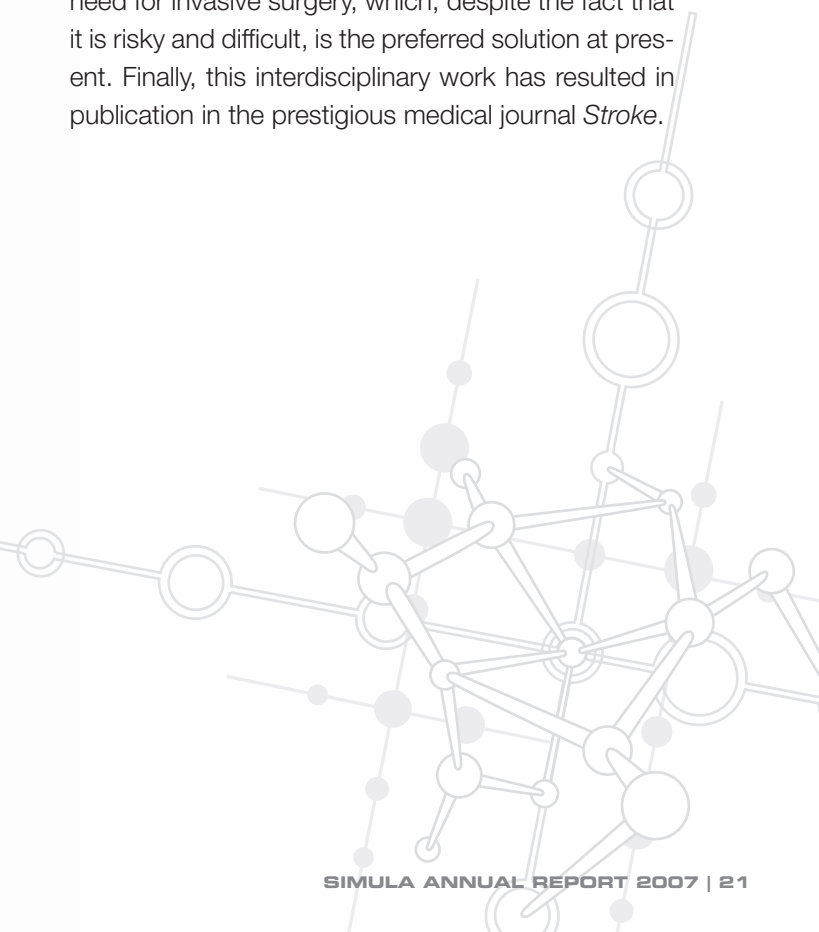
One of the CBC's biomedical applications concerns the flow of blood in the circle of Willis. The circle of Willis is an arterial network at the base of the brain. This network is the main supplier of blood to the brain. It ensures a robust/redundant bloody supply system, due to the fact that it connects the four arteries coming from the neck. Around 1% of the population develop aneurysms in or close to this network. Many are harmless, but about 1% of these aneurysms (per year) rupture and thereby cause a life-threatening stroke. Clinicians face a difficult decision when they (often accidentally) discover aneurysms. Invasive surgery is difficult and risky. Non-invasive procedures, such as coiling, are prone to re-development of aneurysms and therefore not the preferred solution. Finally, most aneurysms do not rupture and are therefore harmless.

Clinicians only have rough guidelines to identify the critical aneurysms and they seek new methods to ease and improve their decision making.

We have started to model and simulate the blood flow and corresponding wall tension to predict the likely growth or rupture of aneurysms. Our collaborators are neurosurgeons from the University Hospital of Northern Norway and researchers in medical imaging from the Mario Negri Bioengineering Department in Italy. The cross-disciplinary work between mathematical modelling and calculation, combined with medical experience and real-life patient data, is producing promising results that may be life-saving.

In Norway, about 400 people per year have a stroke because of a ruptured aneurysm in the circle of Willis. By accurately computing the risk of rupture, we can avoid unnecessary and dangerous operations, and predict when an operation is necessary.

In 2007, we simulated a patient-specific bypass surgery where the circle of Willis was augmented by an artery that normally supplies the scalp with blood. This surgery was done to ensure sufficient blood supply to the patient's brain. In the near future, such simulations may be used in the planning of surgery. We also simulated the effect of the filling grade of coil in an aneurysm to investigate why coiling aneurysms often lead to re-growth. Preventing the re-growth of aneurysms is important, because it will reduce the need for invasive surgery, which, despite the fact that it is risky and difficult, is the preferred solution at present. Finally, this interdisciplinary work has resulted in publication in the prestigious medical journal *Stroke*.



## THE SOFTWARE ENGINEERING DEPARTMENT

Given the extent to which modern society depends on software systems, it is of critical importance that the great scientific and engineering challenges of software systems development be addressed. It is the goal of the Software Engineering (SE) Department to contribute to this effort. At a practical level, the SE Department aims to support the private and public software industry in developing higher quality systems that are delivered with improved time-liness in a more cost-effective and predictable way. The overrun of estimates for the cost of, and time required to complete, software development projects is an example of a problem that SE addresses. Combining scientific rigour with practical relevance is an essential trademark of our research.

### International top level

In only five years, Simula has managed to build an institution that is now ranked among the very best in the world in the field of software engineering. In a ranking recently published in *Journal of Systems and Software*, the SE Department is ranked no. 3 among 1361 institutions worldwide. This ranking is the 12th in an annual series and is based on frequency of publications in six leading software engineering journals over a five-year period. The current ranking captures the years 2001-2005. The first two institutions are The Korea Advanced Institute of Science and Technology (KAIST) and National Chiao Tung University in Taiwan. Simula has now passed Carnegie Mellon University/Software Engineering Institute, which was on top in seven of the previous rankings and is considered by many as the most prominent temple of software engineering research.

Perhaps the most successful research laboratory in the history of computing, AT&T Bell Labs, was on top in the

previous two rankings. At the individual level, Professor Magne Jørgensen's research during the first five years of Simula has led to the exceptional achievement of being ranked first among 3918 researchers. For the period 2000-2004, Jørgensen was ranked no. 14.

Another indication of the positioning of the department in the international software engineering research community is its capacity to attract foreign researchers. In particular, after being a visiting researcher for five years and having spent his sabbatical at Simula, Professor Lionel Briand, from Carleton University in Ottawa, Canada, has recently immigrated to Norway with his family to work at Simula on a permanent basis. Briand is editor-in-chief of the *Journal of Empirical Software Engineering*, has an outstanding production and citation record, and was no. 4 in the individual rankings described above. Regarding the reasons for his move, Briand states:

“ I have joined Simula for a number of reasons. Putting aside personal considerations, it was clear to me that, from the way Simula was quickly evolving and converging among the very best, this was to become an exceptional research institution. This stems in part from the way it is structured and managed: Simula is the first research institution I know which is managed with the flexibility and rigour of a top-tier private corporation, where every decision is made with the explicit objective to make its researchers increasingly effective. This explains in large part its ranking among other institutions and why Simula should become an example of reference in the way Norwegian research is managed. ”

< Dag Sjøberg,  
Head of Department, Software Engineering

Opportunities for conducting fundamental yet industry-relevant research at Simula have contributed to the success of the SE department. The flexibility regarding how resources are spent, the funding of industry-relevant studies, and the prospects of long-term, full-time research are also important reasons why the SE department attracts – and retains – excellent researchers. The department's achievements show that it is possible in Norway to be an international leader in selected research areas if resources are focused on talented researchers. The Norwegian Government should be praised for their effort to sustain basic research in information and communication technology at Simula.

### The industry is our lab!

Through research that involves collaboration with industry, the SE Department helps to build a body of knowledge and expertise that is essential for developing higher quality software systems, within shorter timelines, and in a more predictable way. As an engineering discipline, our goal must be to find innovative but realistic solutions to the problems faced by industry. Given the growing role of software technology in all areas of the economy, our impact on innovation in the private industry and public sector is bound to grow in importance. One of our main objectives is to conduct empirical studies that are as realistic as is practically possible. So far, 155 Norwegian and 95 foreign companies have been involved in various studies at Simula; from intensive case studies and action research over many years, to companies that are hired for one to several days to take part in controlled experiments.

The industrial relevance of the research done by the SE Department is recognized worldwide. For example, in an article in the *Communications of the ACM*, August 2007, entitled "A Deja-Vu Look at Software Engineering Researchers Who Care About Practice – Reflections on institutes performing practice-relevant research", Simula is, together with the Fraunhofer Center (Germany and Maryland, US) and the National Information and Computing Technology Center of Australia (NICTA), described as an institution that is "clearly focused on the blending of research/theory and practice".

We apply several means to disseminate our research results to industry. For example, we organize seminars (the most recent seminar for industry held at Simula in October 2007 attracted 90 practitioners and managers), give presentations at practitioner conferences (like JavaZone), cooperate closely with software companies, and publish in practitioner magazines (such as *IEEE Software*), and author (Magne Jørgensen) a regular column in the Norwegian *Computerworld* magazine. Moreover, the SE Department is in charge of three research-based university courses on software engineering at the University of Oslo, one of them with more than 300 students.

## SIMULA INNOVATION AS

### Transforming research into commercial value

Simula Innovation (SI) is the innovation and commercialization company owned by Simula Research Laboratory.

The ambition of Simula Innovation is to create demand for ideas and research collaboration with the Simula Centre, and to demonstrate that the national commitment to the Simula model is innovative and creates value through the commercialization of research-based ICT innovations.

2007 was a year of growth for SI. As in 2006, SI increased the amount of grants received from public funding. An increase of almost 300 per cent from 2006 has meant a substantial growth in the number of research ideas that have turned into commercialization projects, as well as an increase in permanent and project-based staff to a total of 11.

2007 also saw growth in activities. In 2007, SI had 12 projects in its portfolio, evaluated 15 new ideas, initiated three new technology verification projects, decided on two new spin-outs, filed one patent and evaluated two patent ideas.

SI also continued its focus on further developing the innovation infrastructure at Simula by focusing on the commercial perspectives and applications of the research results. The infrastructure activities included, a workshop on value-based sale in high-

tech start ups, the hosting of a national conference on software patenting (PATSOFT 2008), and an in-house Innovation Day. High-quality research-based ideas flourish at Simula. In connection with the Innovation Day, an idea competition was held, yielding 15 new ideas for commercialization.

To further strengthen the innovation infrastructure, SI is playing an active role in the development of a training course in research-based innovation and commercialization, which will be given at the recently established Simula School of Research and Innovation.

During 2007, SI reported quarterly to the Executive Board on the following three areas of focus:

#### 1. Increased focus on commercialization in Networks and Distributed Systems through SimTel Innovation

The SimTel Innovation project was launched in May 2007 and is a joint project between Simula Innovation and Telenor R&I. The aim of the project is to conduct highly innovative research and to pursue ideas and research results commercially. Currently, the SimTel research activities are focusing on improving the service available to, and quality of, wireless and mobile terminals.

Two other projects from Simula's Department of Networks and Distributed Systems produced excellent results in their technology and market verification projects during 2007. As a result, it has been decided to establish two new spin-outs based on the Resilient Routing and Lividi projects.

- LIVIDI has developed solutions for improving the cost-effectiveness of providing scalable and flexible streaming services in an operator's network. It also greatly enhances the end user's viewing experience by automatically adapting the quality of the video stream to terminal characteristics, network quality, and personal preferences. Importantly, the network is relatively unaffected by the number of receivers, in contrast to other known solutions.

< Lars Bjørn Larsen, Acting Director of Simula Innovation AS



- RESILIENT has patented mechanisms that allows very fast (less than 50 milliseconds, and thus imperceptible by an end user) recovery from any link and router failure in an IP network. This is achieved by preparing for a failure in advance, instead of calculating new paths after the failure has occurred. The solutions can handle multiple failures in the network, and can also be used with networks using protocols other than IP.

## 2. Develop and capitalize on strategic projects in the commercialization portfolio

Technology and market verification is crucial in the development of commercially sustainable projects. In 2007, four projects received "Verification grants" through Simula Innovation from the Norwegian Research Council of Norway's/FORNY programme, amounting to MNOK 4 150 to further facilitate the demonstration of the viable commercial application of the results.

In addition to Resilient Routing and Lividi, the projects that received verification grants were:

- ECG ANALYZER. After 10 years of research at Simula's department of Scientific Computing, a technology for automatically diagnosing and visualizing myocardial infarction through computer-based mathematical calculations based on ECG measures is now undergoing initial validation studies using real patient data.
- APPLIED KNOWLEDGE. Simula has established an extensive knowledge base regarding the measurement of individual skills and the quality of solutions. This knowledge is now being developed into a technology for the in-depth testing of IT developers to assist recruiting and skills management.

Two spin-out companies from Simula Innovation showed promising results in 2007. Through two minor share issues in Symphonical AS, which received the Simula Innovation Award in 2006, it was possible to attract more than 4 MNOK in external capital. The company has made considerable headway towards launching the first public beta version of its product.

This year, the Innovation Award was presented to World Beside AS for their unique project to create a new digital learning platform for natural science education that is based on a full model of the physical

world. The company is a strategic collaboration with Birkeland Innovation and received substantial funding in 2007 from the Ministry of Education and Research through the Department of Education in Oslo (the Real Digital programme) and from StatoilHydro.

## 3. Extend the T2M network, develop the T2M methodology further, and follow up on the T2M Team Innovation

SI is an active network organization that enlists expertise and services appropriate to the needs and progress of the commercialization portfolio. During 2007, the T2M network (the comprehensive network of contacts within national and international business communities, investors and other resource people), has been strengthened primarily within finance, venture, innovation management, and IPR.

Since 2005, SI has been developing and testing its process for research-based innovation and commercialization, T2M (Technology to Market). In 2007, a pan-Nordic project that was initiated by SI was selected from 100 projects for funding by the Nordic Innovation Centre (NICe). The two-year project, which has a total budget of 8 MNOK, will use the T2M methodology as a starting point and aim to establish best practices for research-based innovation and commercialization. In addition, T2M Nordic will create the first Nordic think tank for the commercialization of research, and provide recommendations on policy to the Nordic Council of Ministers.

Key partners in the project are Innovationlab (DK), Kebbison (SE), the Helsinki School of Economics (F), Accenture Innovationlab (Nordic), Symphonical (N), and the Nordic ICT organization represented by ICT Norway, see also [www.t2mnordic.com](http://www.t2mnordic.com).

Many researchers at Simula are interested in the possible applications of the research results. Through the development of the T2M Team Innovation (see illustration) SI wants to build awareness and interest in the possible commercial applications of Simula's excellent research results.

[ **simula.innovation** ]

## KALKULO AS

Kalkulo AS is a wholly owned subsidiary of Simula Research Laboratory and is run on fully commercial terms. It provides consulting services within the field of technical software. The company's core competence covers various aspects of computer science and applied mathematics, such as scientific visualization and geometric modelling. Current members of staff have backgrounds in both academia and industry and have experience of building software, ranging from core algorithms to complete applications.

Kalkulo did very well financially in 2007. Total revenue were more than 8 MNOK, with a net profit of 1.9 MNOK.

### Geological modelling

Kalkulo continued to play an important role in Simula's activity with StatoilHydro<sup>1</sup> in 2007. The company was involved in several sub-activities, creating software that helps geoscientists understand geological processes better.

In one of these activities, Kalkulo is developing a complete application called the 4D Lithosphere Model that will enable geologists to study the geology of the earth at various scales and at all geological times. The background for this application is that in order to get a holistic understanding of geodynamic processes, it is necessary to integrate a wealth of geoscientific data

spanning several magnitudes of scale and resolution. To fully understand the geological evolution of a region of particular interest, information from crustal, lithospheric and mantle structure and topography need to be combined with plate kinematic frameworks.

Another important activity in the collaboration with StatoilHydro is called Compound Modelling. This is an application developed by StatoilHydro for modelling complex geological processes and phenomena in earth models. Before Kalkulo entered the project, this was a 2D application because of the huge leap in complexity required by going to 3D. Kalkulo's contribution to this project has been to make a 3D version of Compound Modelling by providing very efficient and accurate numerical algorithms. It is very satisfactory to note that the 3D version is now being used in production.

### Medical modelling

Kalkulo is working with Simula Research Laboratory (SRL) on a project whose goal is to verify a technology developed at SRL. This technology has its roots in Simula's project to develop software for simulating the electrical activity of the heart. Its purpose is to determine from ECG measurements whether or not a patient has ischemia. Ischemia is a condition that precedes heart infarction and is reversible. The algorithm also estimates the possible size and location of ischemia. This technology has now reached a state of maturity in which it is ready to be tested on data from real patients. Kalkulo's contribution to this verification project consists in transforming 3D medical imagery into 3D geometrical models, which is a prerequisite for the basic algorithms.

Another part of this project involves studying how sensitive the algorithm that estimates ischemia is with respect to differences in the human anatomy. How accurate must the geometrical models be in order to get reliable estimates for the ischemia? In order to answer this question, Kalkulo has developed a software tool suitable for creating a range of different 3D models of the human torso.



< Christian Tarrou, Acting Director of Kalkulo AS

# kalkulo

## Computer games

Kalkulo played an important role in the definition and initial development of a project called World Beside (WB). The goal of this project is to develop a PC game for educational purposes. World Beside combines three components: A multiplayer gaming framework, a computer model of the real world and educational content taken from the curriculum in school. Within this environment, different games and content holders for learning purposes are being developed.

During the latter half of 2007, it was realized that this activity was demanding large resources and needed a high degree of focus. It was therefore decided that Kalkulo should transfer technology and personnel to a separate company called World Beside AS, while holding a significant stake in this company.

## Position, goals, and strategy

At 1 January 2008, Kalkulo had four employees. Kalkulo aspires to continue the good trend from 2007 by focusing on securing economic growth in 2008. This can best be achieved by promoting growth in Kalkulo's areas of core competence. The current status of the various projects and other factors indicate that Kalkulo's budget for 2008 should be based on revenues on a par with those in 2007. The recruitment process has begun.



## KALKULO

*n.* from Norwegian *kalkulus*.

Borrowed from Late Latin *calculātus*, past participle of *calculāre*, from Latin *calculus*; pebble, small stone used in counting.



While Kalkulo is working to meet its short-term goals of securing economic growth, the process of defining mid- and long-term goals will begin. One such mid-term goal is to deliver consulting services in all fields in which SRL conducts research. Initial steps towards meeting this goal will be taken in 2008, but with limited risks and costs.

<sup>1</sup> Statoil and Hydro's petroleum operations merged in 2007.

## SIMULA SCHOOL OF RESEARCH AND INNOVATION AT THE UNIVERSITY OF OSLO

In December 2006, it was announced that the Ministry of Education and Research would allocate MNOK 5 to establish a school of research at the Simula Research Laboratory (Simula). Simula then invited industrial players to buy shares in the company, resulting in a school for research which is jointly owned by Simula, StatoilHydro, Bærum Municipality, Telenor, SINTEF and the Norwegian Computing Centre. The Simula School of Research and Innovation at the University of Oslo (the Simula School) was founded on 8 May 2007. The company's object is to educate ICT researchers at the doctoral level in close cooperation with the University of Oslo.

The decision to set up a school of research was to some extent motivated by the results of the 2004 evaluation of Simula, which pointed out that Simula could be even better at educating doctoral students. The Committee was of the opinion that the number of PhD students relative to senior researchers should be increased, and that Simula could thereby intensify the overall level of activity at the centre.

With the Simula School, Simula is well equipped to expand its PhD programme in terms of quality and quantity. The close cooperation with Simula's research departments and the University of Oslo, and the engagement in close, binding cooperation with industrial players, will help the Simula School produce highly qualified ICT researchers who will be attractive to the world of academia as well as to business and industry.

### Opening of the school

The Simula School was formally opened on 20 August. The guest list included representatives of universities and research communities, industry, politicians and employees of Simula.

State Secretary Rikke Lind of the Ministry of Trade and Industry presided at the opening ceremony. In her speech, Lind pointed out

the importance of strengthening the bonds between industry and academia. In that respect, the establishment of the Simula School is entirely commensurate with the ministry's intentions.

### The nature of the business

The Simula School is responsible for all the educational activities in the parent company Simula Research Laboratory. The school shares premises with the parent company at IT-Fornebu and routinely benefits from good professional interaction with Simula.

The objective of the Simula School is to provide instruction of a high international calibre in ICT-related subjects that are in demand in the workplace. Education takes place within Simula's three specialised fields of research: Networks and Distributed Systems, Scientific Computing and Software Engineering. The school cooperates closely with the University of Oslo, and the University's regulations for PhD programmes apply in full.

### OWNERSHIP STRUCTURE

At 31 December 2007, the Simula School of Research and Innovation had the following shareholders:

Simula Research Laboratory AS	(56%)
Norsk Hydro Produksjon AS	(21%)
Bærum Municipality	(14%)
Telenor Communication II	(7%)
SINTEF Holding AS	(1%)
The Norwegian Computing Centre	(1%)

< Kristin Vinje,  
Director of the Simula School of Research and Innovation AS

Through the Simula School, students will establish strong bonds to business and industry, not least as a result of exchange programmes and international co-operation. Through specific initiatives and activities, the school will ensure good academic and social conditions for students' research to guarantee good, well-focused performance.

#### Key tasks during the year of establishment

During the first calendar year in the company's history, the school focused on recruitment and the further development of the programme. The research director and people in positions as research trainees, PhD positions and postdoctoral fellows have been recruited. Further, employees initially hired as PhD students or postdoctoral fellows by the parent company Simula have been transferred to the Simula School.

One advantage of the school is the interaction between students (e.g. research trainees, PhD or post-doctoral research fellows), the supervisors and the Simula School. Documentation describing the role of supervisor and the occupational categories has been compiled by the working groups. Based on that, a manual will be drawn up to describe how the various elements work together. Efforts have been initiated to further develop the discipline-related elements of the school, including topics such as innovation and research management. In addition, a course in writing and presentation technique is being offered in collaboration with Penn State University.

#### Cooperation

The Simula School aspires to cooperate with relevant players in the public and private sectors and with educational and research institutions in Norway and abroad. During the year of establishment, the Simula School engaged in different activities to introduce the school to potential industrial players which might be potential partners. Dialogues were initiated regarding the establishment of cooperation agreements with international academic institutions.

#### Prospects for the future

The Simula School aspires to increase the number doctoral students at Simula while improving educational quality. There is a vast demand for graduates with strong ICT expertise. This applies to the public and private sectors alike. If funding could be secured, the Simula School could produce 15 highly qualified, sought-after graduates each year.

In 2007, Simula received MNOK 5 from the State to start the Simula School and a pledge of further funding, without that pledge mentioning any specifics. The Simula School has applied for additional funding, but Norway's government budget for 2008 contains no



> Research Trainees, PhD Students and Postdoctoral Fellows at the Simula School of Research and Innovation

promises of increase. It will be difficult for the Simula School to become fully operational in the years ahead if the State fails to provide additional funding. Further efforts will be made to communicate the need for more state funding, at the same time as agreements will be concluded with external players that would like to fund fellowships at the Simula School.

## DOCTORATES AND MASTER'S DEGREES\*

■ Doctorates	Theses	Supervisors
Glimsdal, Sylfest	Numerical simulation of tsunamis	Geir K. Pedersen, Hans Petter Langtangen, Henning Dypvik
Hansen, Audun Fosselie	Fast reroute in IP networks.	Stein Gjessing, Olav Lysne
Kampenes, Vigdis By	Quality of design, analysis and reporting of software engineering experiments	Dag Sjøberg, Tore Dybå
Kvalbein, Amund	Fast network recovery	Stein Gjessing, Olav Lysne
Musunoori, Sharath Babu	Quality aware application service placement in a stochastic grid environment	Frank Eliassen, Richard Staehli
Reinemo, Sven-Arne	Quality of service in interconnection networks	Tor Skeie, Olav Lysne

■ Masters	Theses	Supervisors
Andresen, Simon Røyrvik	Measuring change. Creating and validating a tool for extracting change-level measures from version control systems	Bente Anda, Hans Christian Benestad
Arntsen, Andreas	Maintenance of receiver groups in TCP-friendly multicast for wide-area video distribution	Tor Skeie, Carsten Griwodz
Basberg, Johan Herman Wilhelm	Flerkonfigurasjonsruting (MRC) som utgangspunkt for resursallokering i datanettverk	Olav Lysne
Beskow, Paul Bernhard	Migration of Objects in a Middleware for Distributed Real-time Interactive Applications	Carsten Griwodz, Pål Halvorsen
Dahle, Knut Johannes	Praktisk bruk av parprogrammering – et industrielt studie	Hans Gallis, Erik Arisholm
Dybvik, Bjørn Arne	Ytelseanalyse av FRoots og Dimension-Order	Åshild Grønstad Solheim, Taric Cicic
Fuglerud, Magnus Jensen	Implementing and Evaluating a Fault-proneness Prediction Model to Focus Testing in a Telecom Java Legacy System	Erik Arisholm
Furulund, Kristian Marius	Empirical Research on Software Effort Estimation Accuracy	Kjetil Moløkken-Østvold, Magne Jørgensen

■ Masters	Theses	Supervisors
Gjersøe, Andreas Georg	Automatisert datainnsamling og kvalitetssikring av prosess og produktdata for utvikling og bruk av feil-prediksjonsmodeller for et Telecom Java Legacy System	Erik Arisholm
Gran, Ernst Gunnar	En studie av flytkontroll og bufferstørrelser i Ethernet som tett koblet nettverk	Olav Lysne
Grønsund, Pål Rolfen	A Field Study of WiMAX Performance	Tor Skeie, Paal Engelstad
Hamar, Robert Bauck	Kompilering av mindre Python-moduler til C++	Kent-André Mardal
Haug, Terese Helene	A Systematic Review of Epirical Research on Model-Driven Development with UML	Bente Anda
Jacobsen, Andreas	Implementing and Testing the APEX I/O Scheduler in Linux	Pål Halvorsen
Knatten, Anders Schau	Coupling Diffpack with Sparskit and pARMS	Xing Cai
Ma, Guo Wei	An Extension of Parallel Diffpack with Trilinos	Xing Cai
Nyquist, Tommy Andre	Evaluating Local Proactive Recovery Schemed for IP Networks	Tarik Cicic, Audun Fossellie Hansen, Amund Kvalbein
Oudenstad, Johannes	The design and evaluation of a QuA implementation broker based on peer-to-peer technology	Frank Eliassen
Ring, Johannes Hofaker	A Python Library for Solving Partial Differential Equations	Hans Petter Langtangen
Skaara, Bergfrid Marie	Hop-by-hop Flow Control in Ethernet Networks; Implementation and Simulation-based Analysis of Performance	Tor Skeie
Solberg, Kjell Andreas	Evaluating the performance gains of specialization in a stream handler architecture	Carsten Griwodz, Pål Halvorsen
Sørli, Linda Prytz	Automatisk og manuell skåring av Javaoppgaver i programmeringstester En prototypeimplementasjon av perstinens for bruk i ferdighetstester	Gunnar Bergersen
Tingstad, Martin Burheim	Improving Inter-subdomain Communication and Load-balancing for the Parallel Diffpack Library	Xing Cai
Wergeland, Øyvind Matheson	Service Planning in a QoS-aware Component Architecture	Frank Eliassen

\* candidates supervised throughout their PhD/MSc programmes by researchers at Simula Research Laboratory

## LIST OF PUBLICATIONS

Simula only reports publications where a significant part of the research has been funded by Simula. By this we mean that at least one of the authors of the reported publications must have his/her main affiliation with Simula, and has contributed to the publication as specified in Simula's publication guidelines. Publications from people in part-time positions at Simula are generally not counted unless the research is specifically performed as part of their employment at Simula. Such exceptions from the main rule are very few, and must in all cases be approved by the head of department.

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C. Griwodz and R. Zimmermann. *Multimedia Computing and Networking 2007*, SPIE, Bellingham, WA, USA, ISBN: 9780819466174, 2007.

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S. Glimsdal. *Numerical simulations of tsunamis*, PhD thesis, University of Oslo, 2007.

A. F. Hansen. *Fast Reroute in IP Networks*, PhD thesis, University of Oslo, 2007.

V. B. Kampenes. *Quality of design, analysis and reporting of software engineering experiments: A systematic review*, PhD thesis, University of Oslo, 2007.

A. Kvalbein. *Fast network recovery*, PhD thesis, University of Oslo, 2007.

S. B. Musunoori. *Quality Aware Application Service Placement in a Stochastic Grid Environment*, PhD thesis, University of Oslo, Oslo, Norway, 2007.

Sven-A. Reinemo. *Quality of Service in Interconnection Networks*, PhD thesis, University of Oslo, 2007.

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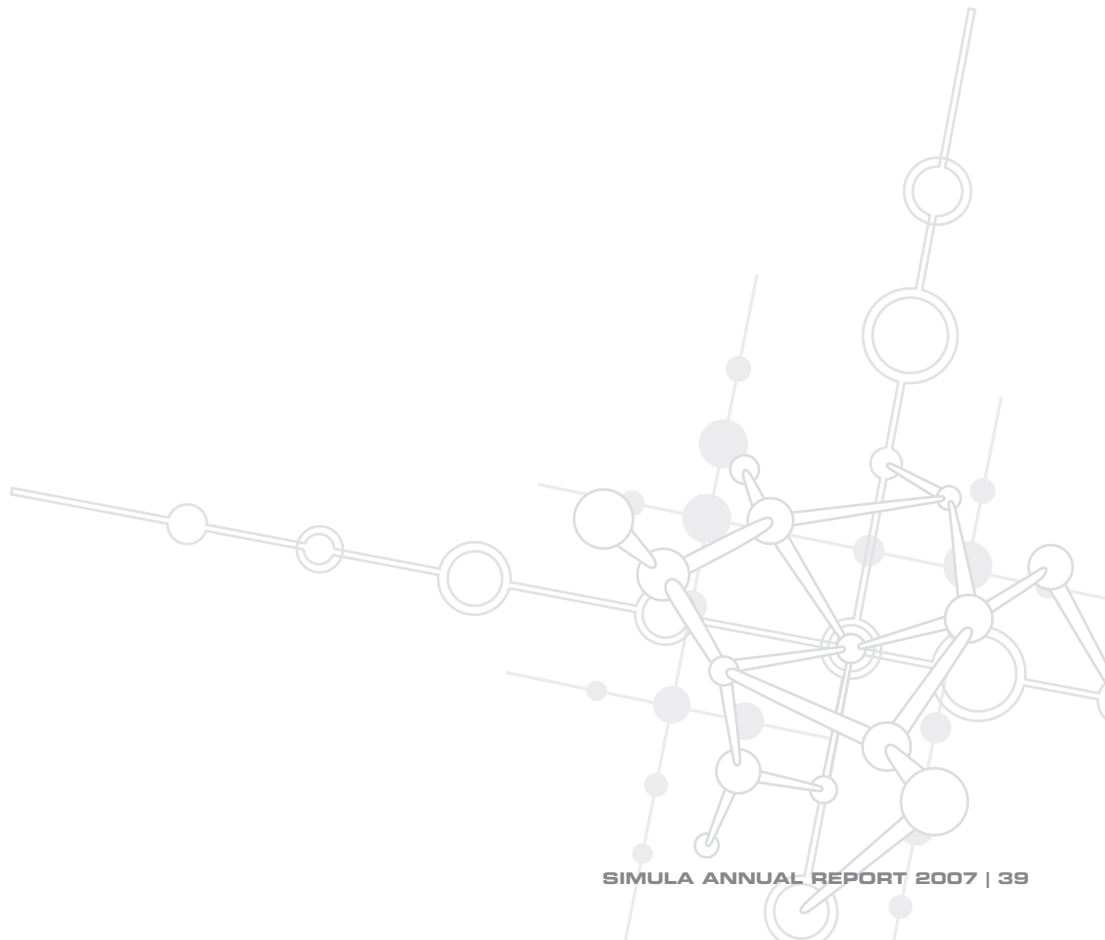
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**SIMULA RESEARCH LABORATORY**

MARTIN LINGES VEI 17  
P. O. BOX 134  
1325 LYSAKER, NORWAY

PHONE: +47 67 82 82 00  
FAX: +47 67 82 82 01  
**[WWW.SIMULA.NO](http://WWW.SIMULA.NO)**