THE STAFF

2003

[simula . research laboratory]

THE BOARD

Annual Report
Årsmelding

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Simula Research Laboratory is a research centre that conducts basic long-term research in selected areas of information and communication technology. The centre's operations are intended to contribute to innovation in Norwegian industry.

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Is there a theory of software development?

Software is part of virtually every modern technological device; nowadays, progress in technology is frequently expressed in terms of new software components. Similarly, software is increasingly important in all aspects of science; our ability to understand nature by analysing computer simulations and the results of physical experiments is largely contingent on the development of software. Finally, as a consequence of modern software technologies, the way people communicate is about to change dramatically. Software is changing our civilisation.

Internationally, development of software is a huge industry. Because of the impact of software and the efforts invested in its development, it is worthwhile to try to understand how modern software is developed, updated and maintained. The Department of Software Engineering at the Simula Research Laboratory has been addressing this issue for quite some time. It has been astonishing to see how the department's research has exposed a lack of a fundamental, accepted body of theory that describes how software should be developed. Certainly, people have considerable experience with, and even strong opinions on, the issue, but there is nonetheless no generally accepted theory based on scientific methods.

Simula's scientists approach the issue of a theory of software development as a basic research problem. They are currently examining fundamental questions that relate to how a theory could be formulated, and what sort of experiments should be performed to gather the data upon which the theory will be based, and to test the resultant theory' acceptability. So far, a rather comprehensive apparatus has been established for carrying out experiments and analysing results. Several large-scale experiments have been completed, and results have been presented at international conferences, giving rise to many interesting discussions. Generally speaking, the measurements are of limited interest on their own, since they relate solely to specific tasks and situations. To be useful for software developers, a theory should be developed that synthesises the results into a unified framework. Our hope is that experiments will provide hints and insights that will eventually lead to better understanding, a prerequisite for theory formulation. The experiments have revealed that the different approaches preferred by programmers engender major differences in development time and software quality. This indicates that improved understanding may lead to better practices and thereby to better quality and lower costs.


Professor Aslak Tveito, Managing Director

Simula Research Laboratory considers this research to be of great importance, from the economic as well as the scientific point of view. Our intention is to strengthen this activity, and our aim is to achieve a leading role in this field on the international arena.

The Scientific Advisory Board

The Scientific Advisory Board (SAB) is appointed by Simula's Board to provide focussed professional advice on Simula's operation. Simula Research Laboratory has appointed two internationally recognised researchers within each of the fields represented at Simula. The SAB meets once a year at the Simula Research Laboratory. The SAB consists of the following members:

Networks and Distributed Systems

Prof. José Duato, Universidad Politécnica de Valencia
Prof. David Hutchison, Lancaster University, UK

Scientific Computing

Prof. Rolf Jeltsch, ETH Zürich, Switzerland
Prof. Michael Thuné, Uppsala University, Sweden

Software Engineering

Prof. Malcolm P. Atkinson, University of Glasgow, UK
Prof. Dieter Rombach, University of Kaiserslautern, Germany

The owners of Simula

Simula Research Laboratory is a limited company jointly owned by:

- Norwegian Government
- Norwegian Computing Center
- Sintef

The operation of Simula Research Laboratory is financed with grants from the Ministry of Education and Research, the Ministry of Trade and Industry, and the Ministry of Transport and Communication. The grants are administered through the Research Council of Norway, which will also be in charged of the evaluation of the centre, with support from international experts.

The Board of Directors

Executive Vice President/CTO Berit Svendsen, Telenor, Chairman
Professor Odd Gropen, University of Tromsø, Vice Chairman
Professor Kjell Bratbergsengen, Norwegian University of Science and Technology
Vice President, Research Tore Gimse, Sintef
Managing director Lars Holden, Norwegian Computing Center
Professor Magne Jørgensen, Simula
Post. Doc. Amela Karahasanovic, Simula
Adviser Cecilie Ohm, University of Bergen
Professor Ragni Piene, University of Oslo
Research Scientist Tor Skeie, Simula

Board Report 2003

The Simula Research Laboratory (Simula) experienced a year of strong growth and production in 2003, based on a high level of scientific activity. The number of full-time positions climbed from 36 to 54 in 2003, meaning the Centre has reached the size that was projected at the time of its establishment in January 2001. Meanwhile, Simula's ‘neighbourhood’ has become much more lively since a number of new tenants moved into the IT and Knowledge Centre at Fornebu.

2003 has been a very active year at Simula, with the adoption of a new strategy being one of several important milestones. Applicable to the end of 2005, the strategy states that Simula's paramount objectives are as follows:

1. To develop research departments that perform research of the highest international calibre;
2. To co-operate with Norwegian universities to educate graduate-level students;
3. To promote the establishment of businesses based on the Centre's research results.

During the year, Simula hired managers for the Scientific Computing Department and the Centre as a whole. Professor Aslak Tveito was appointed Simula's managing director as of 1 May 2003, having served as acting managing director since May 2002. Professor Morten Dæhlen was appointed research director of the Scientific Computing and Innovation departments as of the same date.

In 2003, right on schedule, Simula achieved the growth initially projected at the time of its establishment with respect to scientific activity, the number of full-time positions and its financial parameters. The Centre's premises are also fully developed, covering roughly 2700 square metres of rented space in the former airport terminal building at Fornebu outside Oslo.

Several other IT enterprises joined the Fornebu community during the year. At year-end 2003, the terminal building housed 35 tenants with a total of approx. 500 employees. Moreover, several major enterprises signed contracts to move in early in 2004. Simula's relationship with the building's owner, IT Fornebu, has been replete with discussions about the lease agreement and issues related to construction site noise in the terminal building ever since Simula moved in, in late 2001. Both matters have now been clarified.

Simula's Board of Directors had four ordinary meetings in 2003, as well as one extraordinary meeting devoted exclusively to the appointment of a managing director. The Board was also briefed on the regulations regarding competence that the administration has drawn up, which relate specifically to legal competence in connection with commercialisation projects.

NATIONAL COLLABORATION

Simula's strategic objectives call for good, broad-based collaboration both within Norway and on the international arena. For instance, it is absolutely essential to maintain close collaboration with the four Norwegian universities, since Simula is not an educational institution. Continuous efforts have been made to develop extensive collaboration with these universities, and the Board has resolved that this co-operation is to be maintained and developed further.

In 2003, Simula was engaged in 14 externally funded joint projects with Norwegian universities and research institutions, and applications were submitted for several new projects. Simula also engages in extensive collaboration, using funds from its own basic subsidy.

The administration plans to continue Simula's close teaching collaboration on undergraduate studies with the Department of Informatics at the University of Oslo. National colla-boration regarding graduate-level studies should be strengthened.

INTERNATIONAL COLLABORATION

International collaboration is profoundly important to Simula. In 2003, the Centre had a total of 44 partners in various fields. Most of Simula's partners are European, but the USA and other countries are also well represented. The most prolific activity revolved around collaboration on publications and visiting scientists, but Simula was also actively involved in co-operation on teaching, lectures, conferences, software and commercialisation. During the year, Simula set up a one-year visiting scientist programme that was well received, attracting a total of 33 guests from Norway and abroad. Since its inception, Simula has been a partner in a number of applications for EU projects. Two projects have been granted funding and initiated, and three other applications are still pending. In the year ahead, Simula's main focus will be on completing and publishing research material. Few initiatives will be taken to initiate new joint projects prior to the completion of the planned evaluation in 2004.

INNOVATION

Simula has established a separate unit to deal with commercial opportunities generated by research done by Simula and its partners. The new Norwegian Act relating to Universities and Colleges has assigned the universities greater responsibility for commercialis-ing their research results. The Board has decided to initiate collaboration with the University of Oslo with a view to mutual exploitation of the operational innovation expertise inherent in ICT and related topics.

The Simula Centre's own innovation project contributed significantly to the process that led to the University of Oslo Board's decision to establish Birkeland Innovasjon, the university's new technology transfer office for patenting and commercialisation. Further, the University of Oslo bases its commercialisation work on principles devised by the Simula Centre, paving the way for close collaboration between Simula and the University of Oslo in this area.

Simula's Board: Back row from the left: Cecilie Ohm, Ragni Piene, Jarle Nygard, Magne Jørgensen, Tor Skeie, Kjell Bratbergsengen, Aslak Tveito and Berit Svendsen. Front row from the left: Amela Karahasanovic and Lars Holden. Tore Gimse and Odd Gropen were not present during the photo session.

FINANCES

In 2003, Simula earned aggregate operating revenues of MNOK 55.5, and made a loss for the year of ÷ NOK 160 000, which will be covered by equity capital. The going concern assumption applies and is the basis for the annual accounts. The Centre has developed a satisfactory operating structure. No situation has arisen since year end that affects the accounts as presented, and the conditions are present to support continued operation.

ADMINISTRATION AND WORK ENVIRONMENT

Simula conducted an HSE survey among all employees in 2003. The survey covered the following topics: personal and professional development, responsibilities, collaboration, resources, information, management, health, safety and the environment. The results of the survey were presented to all employees, and each division subsequently addressed the relevant issues raised by the survey. Simula's working environment scored well.

At year end, Simula had 72 employees, including 16 women, a slight increase from the year before. Simula aspires to hire more women in future. No work-related illnesses or accidents were reported in 2003. Simula's activities cause no environmental pollution.

PROSPECTS

The Board would like to thank Simula's administration, researchers and other employees for their sterling efforts during the year under review. The Centre is well-positioned for the upcoming evaluation scheduled to be made by an international committee commissioned by the Research Council of Norway in 2004.

The Board has a favourable opinion of the Fornebu community. Despite a certain delay, it is in the process of developing in the right direction. IT Fornebu has a vision of creating an internationally attractive cluster of IT and knowledge-based activities. The Board aspires to make Simula a valuable asset for this community.

Lysaker, December 31, 2003

March 9, 2003
The Board of Directors

Berit Svendsen
(leader)

Kjell Bratbergsengen | Tore Gimse | Odd Gropen | Lars Holden | Magne Jørgensen

Amela Karahasanovic | Cecilie Ohm | Ragni Piene | Tor Skeie | Aslak Tveito

Income statement
Resultatregnskap

	2003	2002
OPERATING INCOME ***Driftsinntekter*** (Note 6)	55 541 364	45 889 088
OPERATING EXPENSES *Driftskostnader*		
Personnel costs *Lønnskostnad* (Note 4,5)	30 420 401	22 613 164
Depreciation of fixed assets *Avskrivning varige driftsmidler* (Note 3)	1 194 071	507 254
Other operating expenses *Annen driftskostnad*	24 845 174	19 381 668
TOTAL OPERATING EXPENSES ***Sum driftskostnader***	56 459 646	42 502 086
OPERATING PROFIT ***Driftsresultat***	÷ 918 282	3 387 002
FINANCIAL ITEMS ***Finansposter***		
Other interest income *Annen renteinntekt*	755 721	1 456 864
Other financial income *Annen finansinntekt*	2 742	324
Other interest expenses *Annen rentekostnad*	179	19 176
Other financial expenses *Annen finanskostnad*	159	854
TOTAL FINANCIAL ITEMS ***Sum finansposter***	758 125	1 437 158
PROFIT ***Årsresultat***	÷ 160 157	4 824 160
ALLOCATION OF PROFIT ***Disponering av årsresultat***		
Transferred to equity *Overført annen egenkapital*	÷ 160 157	4 824 160
TOTAL ALLOCATED ***Sum disponert***	÷ 160 157	4 824 160

Balance sheet
Balanse

	2003	2002
ASSETS ***Eiendeler***		
CAPITAL ASSETS ***Anleggsmidler***		
Fixed assets ***Varige driftsmidler***		
Furniture, equipment, etc. *Driftsløsøre, inventar o.l.* (Note 3)	5 828 567	2 191 766
Total Fixed Assets ***Sum varige driftsmidler***	5 828 567	2 191 766
TOTAL CAPITAL ASSETS ***Sum anleggsmidler***	5 828 567	2 191 766
CURRENT ASSETS ***Omløpsmidler***		
Receivables ***Fordringer***		
Customer receivables *Kundefordringer*	910 105	562 347
Other receivables *Andre fordringer*	1 733 035	346 154
Total receivables ***Sum fordringer***	2 643 140	908 501
Bank deposits ***Bankinnskudd***	7 761 761	8 949 487
TOTAL CURRENT ASSETS ***Sum omløpsmidler***	10 404 902	9 857 988
TOTAL ASSETS ***Sum eiendeler***	16 233 468	12 049 754
EQUITY AND LIABILITIES ***Egenkapital og gjeld***		
EQUITY ***Egenkapital***		
Contributed equity ***Innskutt egenkapital***		
Share capital *Selskapskapital* (Note 7,8)	1 500 000	1 500 000
Total contributed equity ***Sum innskutt egenkapital***	1 500 000	1 500 000
Earned equity ***Opptjent egenkapital***		
Other equity *Annen egenkapital* (Note 8)	4 664 003	4 824 160
Total earned equity ***Sum opptjent egenkapital***	4 664 003	4 824 160
TOTAL EQUITY ***Sum egenkapital***	6 164 003	6 324 160
LIABILITIES ***Gjeld***		
Short-term liabilities ***Kortsiktig gjeld***		
Accounts payable *Leverandørgjeld*	4 448 789	1 677 528
Taxes and other government fees due *Skyldige offentlige avgifter*	2 686 438	1 710 486
Other short-term liabilities *Annen kortsiktig gjeld*	2 934 239	2 337 581
Total short-tem liabilities ***Sum kortsiktig gjeld***	10 069 465	5 725 594
TOTAL EQUITY AND LIABILITIES ***Sum egenkapital og gjeld***	16 233 468	12 049 754

Note 1 – Accounting principles *Regnskapsprinsipper*

The financial statements have been prepared pursuant to the regulations in the Norwegian Accounting Act of 1998 and Norwegian accounting standards.

Main rule for the valuation and classification of assets and liabilities

Assets intended for permanent ownership or use are classified as 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 real 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 actual value as a result of interest rate fluctuations.

Current assets are valued at acquisition cost or market value, whichever is lower. Short-term liabilities are recognised at their nominal values on the date the debt was incurred. Short-term liabilities are not revalued to actual value as a result of interest rate fluctuations.

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

Foreign exchange

Assets and liabilities in foreign currencies are translated to Norwegian kroner at the mid-rates quoted by Norges Bank on 31 December.

Tangible fixed assets

Fixed assets are depreciated on a straight line basis 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

Trade debts and other debts are valued on the balance sheet at their nominal value less provisions for anticipated losses on bad debts. Provisions for losses are based on individual assessments of the collectability 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 as its activities are not considered taxable.

Årsregnskapet er satt opp i samsvar med regnskapsloven 1998. Det er utarbeidet etter norske regnskapsstandarder.

Hovedregel for vurdering og klassifisering av eiendeler og gjeld

Eiendeler bestemt til varig eie eller bruk er klassifisert som anleggsmidler. Andre eiendeler er klassifisert som omløpsmidler. Fordringer som skal tilbakebetales innen et år er uansett klassifisert som omløpsmidler. Ved klassifisering av kortsiktig og langsiktig gjeld er analoge kriterier lagt til grunn.

Anleggsmidler vurderes til anskaffelseskost, men nedskrives til virkelig verdi når verdifallet forventes ikke å være forbigående. Anleggsmidler med begrenset økonomisk levetid avskrives planmessig. Langsiktig gjeld balanseføres til nominelt mottatt beløp på etableringstidspunktet. Langsiktig gjeld oppskrives ikke til virkelig verdi som følge av renteendring.

Omløpsmidler vurderes til laveste av anskaffelseskost og virkelig verdi. Kortsiktig gjeld balanseføres til nominelt mottatt beløp på etableringstidspunktet. Kortsiktig gjeld oppskrives ikke til virkelig verdi som følge av renteendring.

Enkelte poster er vurdert etter andre regler, og redegjøres for nedenfor.

Valuta

Pengeposter i utenlandsk valuta omregnes til balansedagens kurs.

Varige driftsmidler

Varige driftsmidler avskrives over forventet økonomisk levetid. Avskrivningene er som hovedregel fordelt lineært over antatt økonomisk levetid.

Fordringer

Kundefordringer og andre fordringer oppføres til pålydende etter fradrag for avsetning til forventet tap. Avsetning til tap gjøres på grunnlag av en individuell vurdering av de enkelte fordringene. I tillegg gjøres det for øvrige kundefordringer, om nødvendig, en uspesifisert avsetning for å dekke antatt tap.

Pensjoner

Ved regnskapsføring av pensjon er lineær opptjeningsprofil og forventet sluttlønn som opptjeningsgrunnlag lagt til grunn.

Skatter

Selskapet har ikke innarbeidet skattekostnader da virksomheten ikke er vurdert å være skattepliktig.

Note 2 – Financial market risk *Finansiell markedsrisiko*

The company has little exposure to financial market risk.

Selskapet er i liten grad eksponert for finansiell markedsrisiko.

Note 3 – Capital Assets *Anleggsmidler*

	IT equipment and infrastructure *Datautstyr og infrastruktur*	Furniture and equipment *Inventar og utstyr*	Total *Sum*
Acquisition cost 1 Jan. *Anskaffelseskost 1/1*	1 149 202	1 549 818	2 699 020
Acquired 2003 *Anskaffet 2003*	2 452 396	2 344 934	4 797 330
Acquistion cost 31 Des. *Anskaffelseskost 31/12*	3 601 598	3 894 752	7 496 350
Accumulated depreciation *Akk.avskrivninger*	971 402	696 381	1 667 783
Book value 31 Des. *Bokført verdi 31/12*	2 630 196	3 198 371	5 828 567
Ordinary depreciation *Ordinære avskrivninger*	774 914	419 157	1 194 071
Depreciation in % Avskrivning i %	20 - 50%	20 - 33%	

Note 4 – Pension expenses *Pensjonskostnader*

The company has a pension plan that covers a total of 57 people. The pension plan provides defined future benefits. Pension benefits depend on the individual employee's number of years of service, salary level at retirement age, and social security benefits. The collective pension agreement is financed by building up pension funds under the auspices of the Norwegian Public Service Pension Fund.

Selskapet har pensjonsordning som omfatter i alt 57 personer. Ordningen gir rett til definerte fremtidige ytelser. Disse er i hovedsak avhengig av antall opptjeningsår, lønnsnivå ved oppnådd pensjonsalder og størrelsen på ytelsene fra folketrygden. Den kollektive pensjonsavtalen er finansiert ved fondsoppbygning organisert i Statens pensjonskasse.

Note 6 – Operating income *Driftsinntekter*

The company's operating income was as follows (NOK):
Selskapets driftsinntekter fordeler seg som følger (Nkr):

Research funding *Tilskudd til forskning*	54 383 264
Reimbursement for research fellows *Refusjon for stipendiater*	764 956
Other income Øvrige inntekter	393 144
	55 541 364

Note 5 – Payroll expenses, number of employees, benefits, etc. *Lønnskostnader, antall ansatte, godtgjørelser m.m.*

	2003	2002
Payroll expenses *Lønnskostnader*		
Salaries *Lønninger*	24 520 742	18 370 898
National Insurance contributions *Folketrygdavgift*	3 610 399	2 675 368
Pension costs *Pensjonskostnader*	1 575 652	1 004 428
Other benefits *Andre ytelser*	713 608	562 470
Total *Sum*	30 420 401	22 613 164
Average number of employees *Gjennomsnittlig antall ansatte*	48	43

Benefits for leading employees *Ytelser til ledende personer*	**Managing director** *Daglig leder*	**Board of Directors** *Styre*
Salary *Lønn*	856 586	172 000
Pension plan expenses *Kostn. til pensjonsord.*	52 382	
Other remuneration *Annen godtgjørelse*	6 518	

Auditor *Revisor*

Auditing expenses totalled NOK 38 000, while other auditing services came to NOK 14 300.

Til revisor er utbetalt kr. 38 000,- for revisjon og kr. 14.300,- for annen bistand.

Note 7 – Share capital and ownership structure *Aksjekapital og eierstruktur*

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

Selskapets aksjekapital består av 1.000 aksjer à kr. 1.500.

The shares are owned by:
Aksjene er eiet av:

The Norwegian State/repr. by the Ministry of Education and Research *Den norske stat v/Utdannings- og forskningsdepartementet*	80%
The Norwegian Computing Centre *Stiftelsen Norsk Regnesentral*	10%
Sinvent AS	10%

Note 8 – Equity *Egenkapital*

	Share capital *Aksjekapital*	**Other equity** *Annen egenkapital*	**Total equity** *Sum egenkapital*
Contributed equity *Tilført egenkapita*	1 500 000	4 824 160	6 324 160
Profit/loss for the year *Årets resultat*		÷ 160 157	÷ 160 157
Equity at 31 Dec. *Egenkapital 31/12*	1 500 000	4 664 003	6 164 003

Note 9 – Bank deposits *Bankinnskudd*

The company had locked-in bank deposits of NOK 1 459 487 in connection with the lease and NOK 1 404 308 in restricted deposits relating to employees' withholding tax.

Av innskudd i bank er kr. 1 459 487 bundne midler i forbindelse med inngåtte leiekontrakter og kr. 1 404 308 er bundne midler vedrørende ansattes skattetrekksmidler.

The ICON project

Switch, router, system and storage

These days, it is easy to take advanced communication services for granted. At the click of a finger, it is possible to make a computer on the other side of the globe communicate with us, and within seconds we can receive information on almost any topic imaginable.

As we know it today, the Internet is based on long traditions of everyday electronic communications such as telephony, television and radio, all of which are communications services that have been integral parts of our everyday lives for decades.

Switches and routers are one of the main pillars of modern digital information and communications infrastructure. They are the constituent components of most networks, ranging from global telecommunications networks spanning thousands of kilometres to forge bonds between continents, and down to on-chip networks whose mission is to interconnect processors residing fractions of a millimetre apart on the same silicon chip. Switch and router architecture is the science of how to design these components to maximise performance, as well as how to organise a set of such components into co-operating networks.

THE STUDY OF INTERCONNECTION NETWORKS

The ICON Project studies interconnection networks. An interconnection network can typically reside inside a router to deal with the shuffling of internet packets from the router's inputs to its outputs. Other applications include the connection of processors in supercomputers and clusters of workstations or PCs, and the internal networks of scalable video servers. In more technical terms, interconnection networks can be described as short-distance networks that pose particularly high demands in terms of bandwidth, delay and delivery.

One particularly interesting upcoming application of interconnection networks is in chip design. The number of transistors that can be placed on a silicon chip is steadily increasing. We will soon see that a processor will need only a fraction of the space on a chip, meaning the rest of the chip can be used for something else. It can either be used for more processors, effectively creating an on-chip parallel computer, or components now on separate chips can be moved onto the same piece of silicon. Specialised on-chip interconnects will then be needed to facilitate communication between the different parts of the chip.

THREE MAIN ASPECTS

There are several different metrics by which an interconnection network design can be measured. The ICON project focuses on three main aspects that are described in the following subsections:

Routing and cost-effective network topologies: This is the ability to provide high performance in terms of bandwidth and latency for a given application. Different application areas pose very different network requirements. Whereas the internal interconnection network of an Internet router will experience chaotic and "self-similar" traffic behaviour, an application running on a supercomputer may generate highly regular traffic patterns. This has implications for how the network should be dimensioned and connected, as well as for how data should be routed through the network topology.

A year of expansion and consolidation

The department's activities in 2003 concentrated on implementing the research strategy developed in 2002. The strategy states that the goal of the department is to become an internationally recognised contributor of solutions for quality of service (QoS) management in respect of the distributed applications and services of tomorrow.

QoS management refers to the planned allocation and scheduling of network and end-system resources and software algorithms to meet the QoS needs of applications, including provided response time, bandwidth, privacy, safety, accuracy and media-quality (for continuous media). The department aspires to be an international leader in two complementary focus areas:

- Vertical and horizontal interoperation of network QoS mechanisms
- Component architecture support for dynamic management of real-time QoS

THREE NEW PROJECTS

In 2003, three projects (QuA, VINE and ICON) were established on the basis of the department's new research strategy. Considerable time was spent on recruiting staff and producing detailed plans and objectives for each project. The department doubled its staff in 2003, as five new PhD students, one post-doc and one scientific programmer were hired. Half the new positions are funded by outside sources (the Research Council of Norway and Telenor). In other words, 2003 was a year of expansion.

The QuA project is investigating new ideas to enable a wide variety of multimedia and real-time applications to be constructed from off-the-shelf components. In 2003, the project team compiled the core of the QuA architecture in two programming languages, i.e. Java and Smalltalk. The architecture allows programmers to separate aspects of externally observable service behaviour and performance from the way in which a service is implemented. Although the need for this is widely recognised, it is not supported by

area interconnection networks

At the click of a finger, it is possible to make a computer on the other side of the globe communicate with us, and within seconds we can receive information on almost any topic imaginable. (Foto: Jann Lipka, Mira/Samfoto)

Fault tolerance: The ability of a network to sustain operation despite the failure of its components is becoming increasingly important. Research is currently driven by two main developments: First, an increasing number of businesses are dependent on their computer systems for their daily operations. Second, systems are growing at an ever faster pace. The probability that every component will remain fault-free at all times is inversely proportional to the number of components in a system.

In simple terms, network failures are handled by rerouting data that should have traversed a faulty region of a network over another path to its destination. However, the simplicity of the description of this solution is highly deceptive for interconnection networks. Routing paths in interconnection networks have to be chosen very carefully in order to avoid a phenomenon called network deadlock. Such deadlocks occur when the packets in a given set are congested because the paths to their destinations are blocked by other packets in the set. Hence, the packets will all wait indefinitely to make progress.

The challenges inherent in switching from one routing strategy to another while a network is up and running, without creating deadlocks in the transition phase, have been studied by the interconnect community for several years. A general solution to the problem was discovered under the auspices of the ICON project in 2003. This solution may significantly impact the future design of fault tolerant interconnection networks.

Predictable service: As the confluence of network infrastructures from computer networks, telephony networks and radio and TV networks continues, quality of service (QoS) issues are expected to gain increasing importance. The quest for predictable service is as important for interconnect networks as for traditional telecommunications networks. This is perhaps best illustrated where there is an interconnection network inside a telephone switching box; the QoS provided by that box will be limited by the QoS provided by the internal interconnection network. Another area where QoS mechanisms are required in interconnects in storage or video servers.

COMBINATION OF FEATURES

Until recently, the trend has been to develop proprietary interconnect components. This is slowly changing as standardisation gains momentum, leading to standards such as InfiniBand and the forthcoming PCI Express AS. One conceivable/likely scenario for the future is that a few general purpose switching components will dominate the market, and be used in most interconnection networks. This development will be driven by the same forces that pushed a few general purpose processors to take over the micro processor market in the 1980s. This implies that future switching components will have to handle a wide variety of different requirements with respect to routing, network topology, fault tolerance, and predictable quality of service. Providing solutions for such general purpose switching infrastructure components is one of the main challenges facing today's interconnect network community.

component standards such as EJB and .NET.

The ICON project addresses quality of service, including fault tolerance, effective routing and the topologies of switch, router, system and storage area interconnection networks. In 2003, the project team developed general solutions to problems in all these areas (see the main article on this page for further details).

Prof. Frank Eliassen, Research Director

The VINE project focuses on developing solutions for end-to-end Quality of Service support on the Internet that will enable all digital communication to use the same physical network. The project is still in an early phase. A simulator has been developed to serve as a vehicle for the research centred around ring-based networks. The simulator, written in Java, has been posted on the Simula web.

FROM CONSOLIDATION TO PRODUCTION

Although a great deal of emphasis has been placed on recruiting and consolidation, the department produced nearly 30 research papers during the year under review. Half of them appeared in 2003 and about one-third will appear in the early months of 2004. The remaining papers are submissions, mainly to journals. The department has also been successful in obtaining EU funding.

In 2004, the department will direct its attention to producing and publishing research results rather than focusing on further expansion. The number of papers already submitted to journals reflects the department's primary goal in 2004, i.e. to improve the quality of its publications.

Breakthrough for realism in IT development experiments

Over the past three years, the Software Engineering (SE) Department has gradually moved the boundaries of realism in its experiments on IT systems development by replacing students with professionals, artificial tasks with relevant problems, pen and paper with commercial tools, and the classroom setting with real industrial environments.

In the most comprehensive study conducted by the SE Department thus far, four IT companies were selected from a sample of 35 companies that had responded to a call for tender to develop a web-based information system for the Simula Research Laboratory. The companies were all given the exact same project specifications, and asked to develop their version of the system concurrently, but completely independently of each other. Developing the same system facilitates the study of various development technologies and methods. This makes it possible in turn to provide advice about which technology or method is best in a specific context.

There are many ways of developing IT systems; a plethora of methods, tools and programming languages are available. Some companies opt for heavy processes including many formal routines to help ensure control in their development projects, while others opt for more *ad hoc* methods, using 'lighter', less complex processes. It is exceptionally difficult to study the effect of various processes, methods, tools and programming languages in real development projects because a large number of important parameters vary from one project to the next. In actual practice, a given system is never developed more than once.

Consequently, when the SE Department issued a call for tender for a new web-based information system for tracking all the studies made by the department, rather than following the usual routine and selecting one company to build the system, the department chose four IT companies that demonstrated different characteristics. This gave the department, as contractor, the opportunity to study four complete development projects, all of which were given the same requirements specifications. The department was able to identify trade-offs between heavy (and often expensive) and light development processes, identifying characteristics of processes that lead to 'good' systems, and extending and validating research methods for running multiple parallel projects.

A total of 35 companies responded to the call for tender. The bids varied from NOK 55 650 to NOK 559 500! The four companies chosen varied from NOK 70 000 to NOK 450 000 (after negotiation). Two of them used heavy processes, the other two, light processes. The four development teams were interviewed more than a total of 90 times about how they worked. They also completed detailed time sheets daily (split into various development activities and functionalities). The companies sent all their project documents and code to the research team weekly, and communication between the development teams and the customer was documented using a web-based issue tracking system that contained 400 issues by the end of the projects. To evaluate the proficiency of the development teams, each participant took part in an experiment in which they were compared with 220 other persons who had previously taken part in the same experiment.

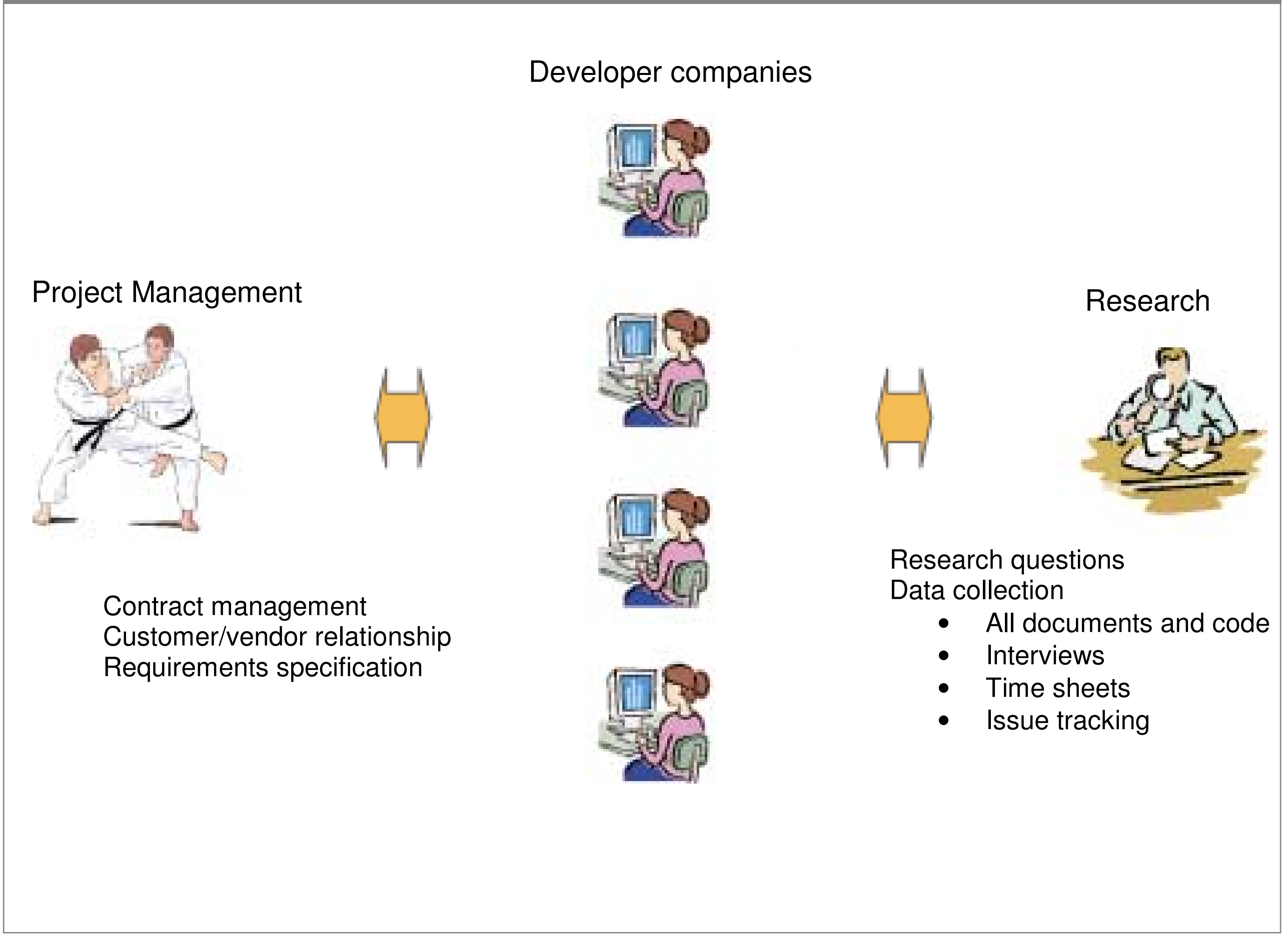
One previously ignored aspect of costing was brought to light by this study: the most expensive company worked in a much more structured manner. It delivered on time and, not least, required little effort on the part of the customer (Simula). The cheapest one delivered far behind schedule (which was very optimistic), and required a great deal of interaction with the customer. This shows that when estimating the cost of a development project, one should also consider the time and effort invested by the customer. Including this in the overall costs may alter the picture. To study the subsequent effect of the quality of a system on the effort required to maintain it, the SE Department will make two versions of the information system operational, then maintain both of them.

More realistic experiments in software development

The Software Engineering (SE) Department has established new principles for carrying out realistic experiments in its field, developed as a result of several years of experience. The department's researchers have replaced students with professional system developers, traded in their paper and pencils for professional tools, and moved out of the classroom and into the workplace. The point is to conduct experiments of direct relevance for industry. While such experiments are demanding to organise and can entail higher risk, they offer the research community, industrial user groups and society new insight into significant problems. The shift towards more realism requires an increase in spending on software engineering experiments. To support technology transfer, the results of the experiments must be presented in a language and a format that are accessible to industry.

The research conducted by the SE Department is motivated by the desire to help the private and public sector IT industry develop better IT systems, using fewer resources. The group is concerned with the

DESIGN OF EXPERIMENT



technical, organisational and human issues that affect systems development processes.

The main objective is to enhance empirically-based knowledge about the effect of different models, methods, techniques and tools on processes and products.

The research revolves around three themes:

Software development effort estimation
This research aims to improve existing models and develop new models, processes and tools for estimation, planning and risk analyses of software projects.

Object-oriented analysis and design
This research aims at evaluating the impact of object-oriented analysis and design technologies on various software quality attributes, e.g. understandability, changeability and correctness.

Professor Dag Sjøberg, Research Director

Methods for research in systems development
To increase continuously the knowledge of how IT systems should be developed, the department also focuses on improving the methods and tools for conducting research in this area. We have started working on principles for how to build and validate robust theories for IT systems development.

Software for PDEs and research collaboration

The project ”Software for PDEs” involves extensive collaboration with external partners. Such collaboration aims at developing applied science applications through alliances with partners who possess expertise on the application in question. Relevant partners are those who acknowledge that Simula’s expertise in numerical methods and modern software development techniques is important for the application.

Over the past few years, the project group has worked with researchers at Ålborg University and Odense Steel Shipyard to study temperature distribution and surface deformation during welding processes. The Norwegian contribution concentrates on numerical methods for dealing with such multi-physics problems, which Simula has implemented as Diffpack simulators. These simulators will constitute part of a future control system for robot-automated welding in ship building. From the mathematical point of view, the extrusion of aluminium is closely related to the welding problem mentioned above. In collaboration with Norsk Hydro and Sintef, Simula is involved in fundamental studies of the numerical reliability of aluminium extrusion simulations, once again using Diffpack as the basis of its efforts.

In 2002, 13 Centres of Excellence (CoEs) were established in Norway. Software for PDEs collaborates closely with three of these centres. It is a partner in the Physics of Geological Processes (PGP). The physics group at this CoE has developed novel simulation methods for friction and fracture, based on fundamental micro-level physics. The long-term goal of the collaboration is to combine such methods with more traditional continuum models to study large-scale geological phenomena, such as mountain formation and continental drift.

For many years, Simula has worked closely with researchers who are now part of the new Centre of Mathematics for Applications (CMA). Traditionally, our common research has focused on robust numerical methods for fluid flow computations. The mathematical development of exciting new mixed finite element methods at this CoE may enable us to simulate the behaviour of complicated visco-elastic geological and technological materials. Our project bridges the gap between mathematical development, here of exotic finite elements, and real-world physical applications, implementing the mathematics in flexible software environments in collaboration with application experts. Simula also works with CMA on geometric modelling and computer graphics, with emphasis on the development of large-scale geometric modelling for interactive visualisation.

The simulation of huge destructive waves caused by natural hazards such as slides, earthquakes, and meteorite impacts is the focal point of collaboration between Simula’s project, the International Centre of Geohazards (a CoE located at the Norwegian Geotechnical Institute), and the departments of Mathematics and Geoscience at the University of Oslo. The long-term goal is to develop robust methods and software that allow different wave models to be applied in different parts of vast ocean areas. Achieving this in a parallel computing setting calls for the type of flexible software methodology Simula has been developing over the past decade.

The Software for PDEs project is involved in numerous, seemingly different, applications. However, all of them are described by closely related partial differential equations. Numerical methods and software components developed in one application are reused in other applications. The maximisation of such reuse is one of the unit’s primary research focuses.

Scientific computing and research partners

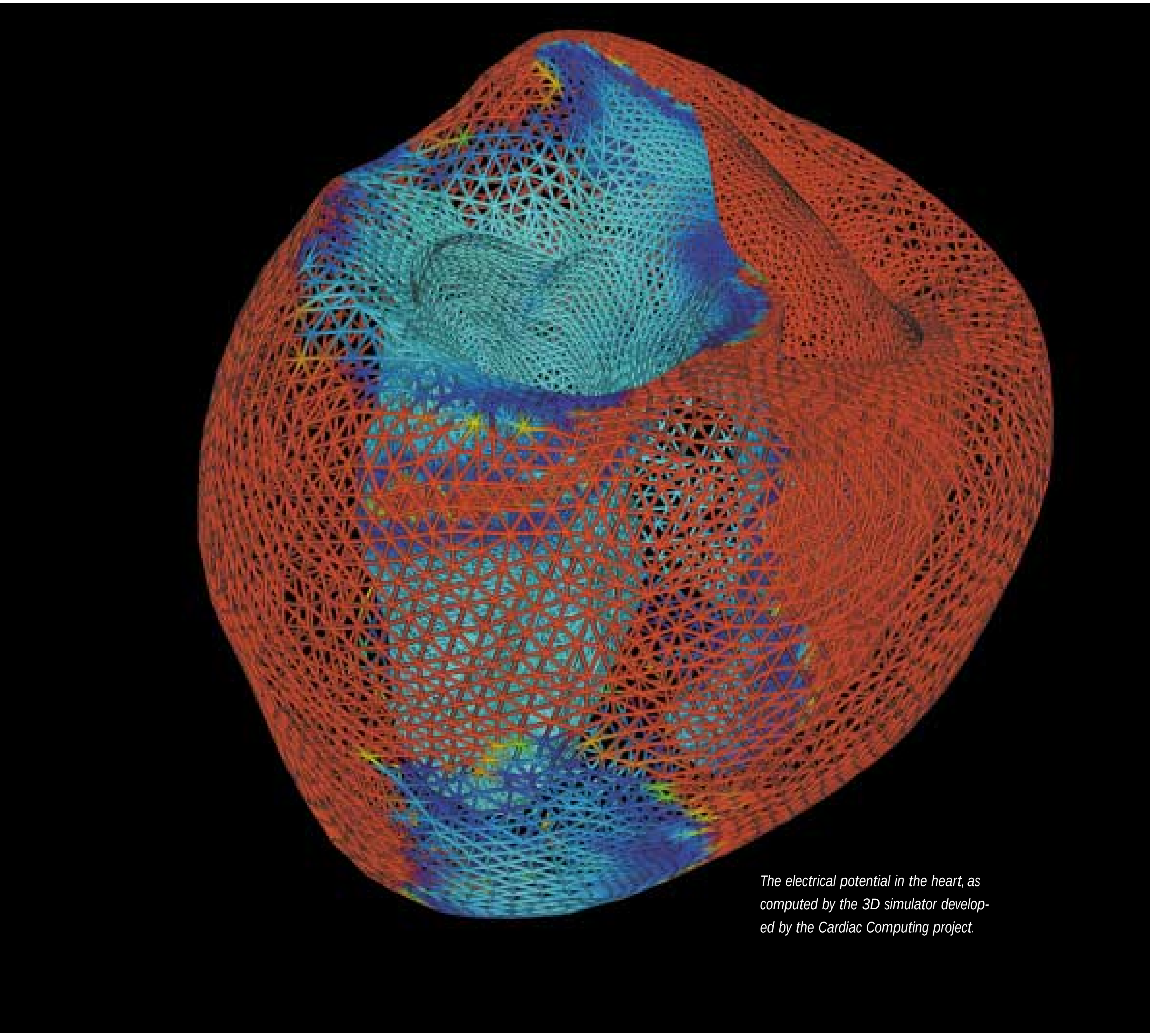
The Scientific Computing Department specialises in numerical methods and software for solving partial differential equations (PDEs). Its aim is to develop efficient, reliable and maintainable software for solving mathematical problems in selected application areas.

This year’s annual report focuses on collaboration with external partners, where Simula’s contribution to joint efforts usually involves the development of efficient solution procedures and high-quality software for PDEs. The Scientific Computing Department is organised around two major projects.

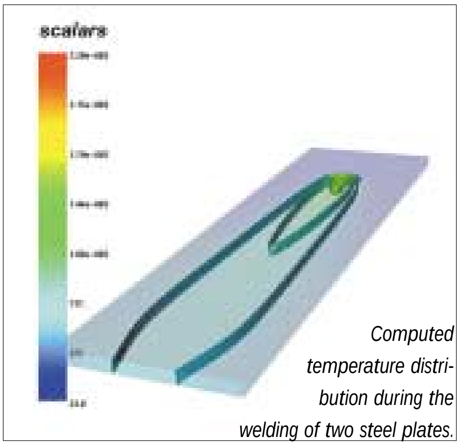
CARDIAC COMPUTING

The long-term goal of the Cardiac Computations project is to build a realistic heart simulator. This calls for the development of numerical methods and software, in addition to extensive verification and validation of the model. The project initially addressed the electrical activity of the heart but, over the past year, its scope has been broadened to include the heart’s mechanical properties. This work is predicated on close collaboration with biomedical experts on cardiac-related issues.

Professor Morten Dæhlen, Research Director of the Scientific Computing and Innovation departments.



The electrical potential in the heart, as computed by the 3D simulator developed by the Cardiac Computing project.



Computed temperature distribution during the welding of two steel plates.

The department’s main research partners on this project are the Faculty of Medicine and the Mechanics Division of the Department of Mathematics, both at the University of Oslo, the Norwegian University of Sport and Physical Education, Ullevål University hospital, Parallab at the University of Bergen, and the Cardiac Mechanics Research Group at the University of California.

SOFTWARE FOR PDEs

The main goal of the project Software for PDEs is to establish generic methods for developing advanced software for compound, complex physical phenomena. The term ‘generic’ refers to the creation of results of practical importance for a wide range of applications. The Cardiac Computations project is closely linked to the Software for PDEs project in the sense that new achievements in the latter are used to solve the PDEs arising from the mathematical modelling of the electrical activity in the heart. The main collaborative efforts relating to this project are described in a separate article on this page.

Why do the birds sing? Sailplane pilots know why!

The above slogan, borrowed from the Norwegian Air Sports Association, illustrates the ambition of the Silent Wings Soaring Simulator developed by Simula and partners. The goal has been to create a sailplane simulation system with an unprecedented level of aerodynamic and physical realism. The project, combining research results from terrain modelling, aerodynamics and real time visualisation, has now reached maturity, unveiling potential commercial spin-offs in several directions.

The Silent Wings Project originated in 1997 in connection with a graduate thesis submitted by a dedicated computer and sailplane enthusiast to the Department for Computer Science, University of Oslo. The initial goal of the project was to develop a software system that would closely mimic the sensations felt by a sailplane pilot flying a real glider.

THE CHALLENGE

The 'computer pilot' was to experience photorealistic views of his or her surroundings, including terrain, water, sky, sunlight, fog, shadows, etc. The geometry and aerodynamic properties of the sailplane were to be detailed and correct. In particular, the glider was to respond, based on the laws of physics, to all types of manipulation of the controls. Even extreme manoeuvres, such as stalling, uncontrolled spinning and rough landings, were to be perceived naturally. Finally, the array of requirements had to be fulfilled in a way that permitted real time visualisation. In effect, a realistic new scene had to be computed and rendered to the screen at least 20 to 30 times per second.

Many of the challenges, particularly those involving visual effects such as sunlight, fog and visibility effects, were already well documented in literature and existed as features in many commercially available games and training simulators. Other challenges, particularly those related to high resolution terrain rendering, posed significant difficulties in the context of sailplane simulation.

LEADING RESEARCH

In contrast to most motorised airborne vehicles, a glider moves at low speed and often at low altitude. Moreover, the pilot is constantly analysing ground and weather conditions to find areas with a high probability of updraft to gain altitude. This makes high quality terrain rendering particularly important. To achieve the necessary degree of real-time terrain detail, the project had to break new ground in the field of terrain modelling. The basic idea was to create a model that, relative to each frame rendered, used only the minimum of terrain data necessary to achieve the requisite quality. This led to the development of a hierarchical terrain model composed of a multitude of local terrain models, each of which is a set of terrains of different resolutions. To render a scene, the system picks only those local models that are visible in the scene. The resolution of a local model is also determined by its distance from the camera.

Research on hierarchical terrain models is of interest in its own

Research-based innovation and collaboration with partners

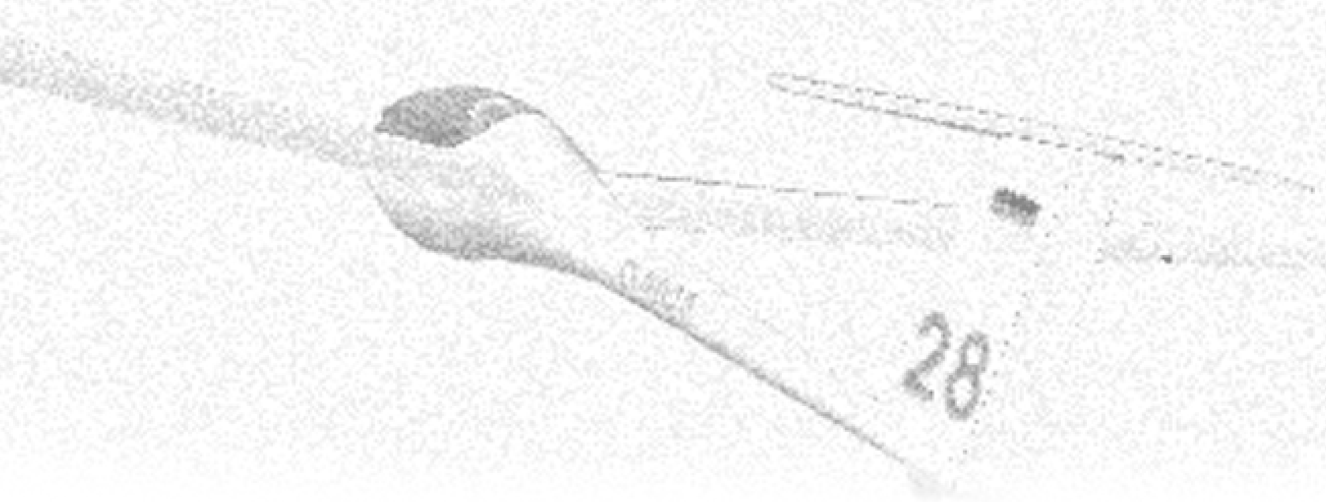
In 2003, Simula's Innovation Department concentrated on two major issues:

- A detailed scan of all research projects at Simula in an attempt to identify results and ideas that might be suitable for commercialisation.
- Collaboration with the University of Oslo to establish a common platform for research-based innovation and venture creation.

FROM WORKSHOP TO SHELF

Simula is engaged in three main fields of research: networks and distributed systems, software engineering and scientific computing. During the year under review, the department considered about 15 specific business ideas at different stages of development.

The department's work on networks and distributed systems engendered interesting results for routing strategies in digital networks. One patent was filed and another is currently under consideration. The department also examined results and ideas about software for distributed systems with a view to handling multi-media data for



The Silent Wings Soaring Simulator includes a large, detailed hierarchical terrain model of the western part of the USA. Here is a snapshot of a simulated trip into the Sierra Nevada Mountains.

right, spawning a separate research project on the subject with applications outside the scope of sailplane simulations.

COMMERCIAL OPPORTUNITIES

Silent Wings technology has been met with considerable interest from potential users. The technology is currently about to be released as a computer game. Together with the Norwegian Air Sports Association, the Simula group has used the technology to create computer animations of the Norglide 2002 gliding competition. Work is also being conducted to extend this to an arena visualisation system for the 2004 World Gliding Championships. In connection with this event, an Asian TV production company is considering using Silent Wings for TV animation for its coverage of the event. Recently, Simula also entered into discussions about using this technology for the simulation and monitoring of certain unmanned aerial vehicles for military applications.

Internet portals (grid applications) and automatic surveillance systems.

Simula's software engineers specialise in developing software tools for empirical studies of software development processes and competence evaluation. In 2003, the department initiated a proof-of-concept project together with selected industrial partners to evaluate its commercial potential. The department's software engineering activities also concentrate on software development projects with a view to setting up a commercial service for the software development industry.

As far as scientific computing is concerned, Simula is continuously developing the software package Diffpack in collaboration with InuTech GmbH of Germany. Potential future business ideas based on Diffpack include electrocardiography simulations and geophysical applications.

COLLABORATION WITH THE UNIVERSITY OF OSLO

Throughout 2003, Simula was deeply involved in developing Birkeland Innovation, a new technology transfer office being set up at the University of Oslo. The department will continue to collaborate with this unit to evaluate business ideas, deal with intellectual property rights, offer entrepreneurship courses and build networks that include experienced entrepreneurs and investors. The existing collaboration between Simula and the University of Oslo also calls for co-operation between Simula's Innovation Department and Birkeland Innovation.

A Brief History of the Simula Programming Language

Everyone who uses personal computers today is familiar with object-oriented user interfaces such as Macintosh and Windows. From the user's point of view, these interfaces are distinguished by what might be called seamless integration between user and machine. Technology once so complicated that only specialists could use it has been packaged in familiar workspace metaphors such as desktops, files, folders and trash cans. With a few clicks of the mouse, 21^{st} century computer users can easily perform tasks so complicated that they would have been inconceivable just a generation ago. Information and communication technology has never been more complex, nor more accessible.

By Jan Rune Holmevik

Professor Ole-Johan Dahl (right) and Professor Kristen Nygaard were awarded both the Turing prize and the prestigious John von Neumann medal in 2002. The picture dates from 2000, when they were appointed as Commanders of The Royal Norwegian Order of St. Olav.

In a historical perspective, there are many explanations for this extraordinary development. One has to do with changing percep-tions of the computer itself, another pertains to fundamental changes in the way computers are programmed and used. Object-oriented programming, introduced through the Norwegian programming language Simula in the 1960s, has been a major influence in this regard. This article chronicles the development of the Simula lan-guage from its inception in the 1950s, through the various stages of development in the 1960s, to the dominant object-oriented heritage we see today.

THE MODERN COMPUTER

The modern computer, as the world knows it today, was invented during and immediately after World War II. At the theoretical level, what characterizes the modern computer is that it is a universal machine. The classic perception of a 'machine', at least in the public opinion, dates back to the industrial revolution of the 18^{th} and 19^{th} centuries. Machines were devices designed for special purpose applications, e.g. to perform specific tasks. Being what Alan Turing called a universal machine, the modern computer differs from this classic perception in the sense that it can be any number of machines, based on which programs we choose to feed into it. The idea of the computer as a universal machine is second nature to most computer users today, and we rarely pause to consider all the different and diverse applications we use computers for on a daily basis.

In the early days of the modern computer, most people did not view it the way we do today. From the late 1940s and well into the 1960s, common perceptions of the computer were frequently associated with the classic notion of special purpose machinery. Computers were typically classified by their intended area of application. People commonly made a distinction between computers for scientific calculations and computers for data processing. The reasoning behind this 'artificial' distinction stems partly from the fact that early computers did not have the power or technology to really fulfill the promise of Turing's universal machine. More importantly however, people's perceptions of the modern computer in those early years were largely influenced by the historical uses of calculating and tabulating machinery, i.e. scientific calculations and data processing.

The early computers of the 1940s and 1950s were typically programmed in binary code. However, as those machines became commercially available in greater numbers, a need evolved for a better, simpler and more flexible way to program them. The first step toward a solution to this problem was the compiler developed by Grace Hopper in the mid-1950s. The compiler was, in essence, a program that could automatically translate code into machine readable format. This, in turn, opened up the concept of high-level programming. This new concept introduced important natural-language-like levels of abstraction, allowing programmers to devote more attention to solving the problems at hand rather than mastering the intricacies of binary coding.

The introduction of high-level programming languages from the late 1950s onward became an important factor in the changing perception of the modern computer. More affordable and powerful machines, coupled with new and easier programming methods, led to accelerating adoption of computers by business and industry in the 1960s. It is fair to say that during that decade, computers went from being novelty items to being woven into the very fabric of modern society. In the academic world, problems related to computer programming in particular led to the establishment of computer science as a new field of research and teaching. Out of these efforts came a host of new programming languages that demonstrated to the world the vast potential of the universal machine.

Among the hundreds of programming languages developed in the 1960s, we find Simula, developed by Ole-Johan Dahl and Kristen Nygaard. Not only does Simula represent Norway's most significant and lasting contribution to international computer science, it also embodies a large and important aspect of the history of computer science in Norway.

THE PRE-HISTORY OF SIMULA

The ideas and experiences that led to the development of the Simula programming language originated at the Norwegian Defence Research Establishment (FFI) in the 1950s. After World War II, the newly established FFI and its sister institution, the Norwegian Institute of Atomic Energy (IFA), conducted a number of large-scale research and development projects, including the development of the first Norwegian nuclear reactor, JEEP I (Joint Establishment Experimental Pile) and the Terne anti-submarine weapon system. In connection with these and other R&D projects, there was an urgent need for complex scientific calculations of all sorts. Thus, in 1948, FFI joined forces with IFA to establish a joint computing centre under the direction of Jan V. Garwick (1916-1989), who became one of the first and most important proponents of modern computers in Norway. Finn Lied, FFI's director from 1957 to 1983, explains:

> *Jan Garwick was one of the most talented students to graduate from the University of Oslo before the war. He came to FFI as head of the Mathematics Section in our Physics Department. During those early years, the late 1940s and early 1950s, he, together with Gunnar Randers, was deeply involved in the construction of the first nuclear reactor at Kjeller. Early on, Garwick became interested in acquiring an electronic computer to help facilitate the many complex calculations related to these projects, and my predecessor, Director Fredrik Møller, was also very interested in that. The machine that they were primarily interested in was called Mercury and was made by the British company Ferranti. This was one of the world's first supercomputers. It was based on a very large number of vacuum tubes and required a whole building of its own, so we built one next to the Physics Department. Cooling and air conditioning systems for the machine occupied the entire basement, the computer itself was installed on the first floor, and offices for scientists and staff occupied the second floor. (Finn Lied)*[i]

When FFI signed the contract for their new Mercury computer, which affectionately became known as FREDERIC, there was virtually no software available for it. Therefore, in preparation for the delivery of the machine, Garwick and his staff at the computing centre immediately began writing the necessary software based on specifications from Ferranti. Thanks to FREDERIC and, more importantly, Garwick's foresight, by the mid- to late-1950s, Nor-

What began as a simple but brilliant idea in the minds of Ole-Johan Dahl (left) and Kristen Nygaard in the early 1960s, has become a new paradigm in computer science world-wide. The picture is from the book "Norsk Regnesentral 1952-2002".

way had its first small but dynamic group of 'computer scientists'. Ole-Johan Dahl (1931-2002), Norway's first professor of informatics, and one of Garwick's assistants at FFI's computing centre at that time, said:

> *I was lucky that I got to do my military service at FFI's computing centre under Jan Garwick. He became my most important mentor and, in many ways, my 'professional coach'. (Ole-Johan Dahl)*[ii]

Another of Garwick's protégés was Kristen Nygaard (1926-2002). Nygaard and Garwick first met in 1940 when young Nygaard's strong fascination for astronomy led him to the University of Oslo's Department of Astrophysics, where Garwick was then a graduate student. Many years later, in February 1948, when Nygaard arrived at FFI to start his military service, he was assigned to the computing centre as Garwick's personal assistant. Over the next few years, the two of them co-operated closely, among other things, on Monte Carlo simulations for the construction of IFA's nuclear reactor. It was, in effect, this project that gave Nygaard his first valuable experience with simulation as a methodology.

In 1950, Garwick began an effort to bring the then new field of Operations Research (OR) to Norway. By 1952, however, as questions pertaining to FFI's upcoming computer acquisition began to occupy him more and more, he appointed Nygaard to head the institute's continued OR efforts. In just a few short years, Nygaard had built up a fairly large group of operations research specialists who did a variety of operational analytical work for the Norwegian armed forces. In the course of this work, Nygaard and his group frequently used simulation as a methodology. They often ran their simulations on FREDERIC. The problem was that every time they wanted to run a different simulation, they had to write a new specialised program for it. This caused Nygaard to start thinking about ways to generate simulation programs automatically. In order to achieve this goal though, he needed a semantic system by which to express the complex real world systems he was analysing.

SIMULA TAKES SHAPE

In 1960, Nygaard and his group were recruited to the Norwegian Computing Centre (NR) to build up a civilian branch of Operations Research. He said:

> *We managed to build up an exciting and lively group there. We all had a fighting spirit and everyone was eager to do new things. We got started on Operations Research pretty quickly, but again we ran into questions related to simulation. (Kristen Nygaard)*[iii]

By that time, the first high-level programming languages had been introduced. The promise they held was the answer Nygaard was looking for. He then proceeded to create a programming language for description and discrete-event simulation of real-world systems. In January 1962, he wrote:

> *The status of the Simulation Language (Monte Carlo Compiler) is that I have rather clear ideas on how to describe queuing systems and have developed concepts that I feel allow a reasonably easy description of large classes of situations. I believe that these results have some interest, even apart from the compiler, since the currently used ways of describing such systems are not very satisfactory. [...] The work on the compiler could not start before the language was fairly well developed, but this stage seems now to have been reached. The expert programmer [Ole-Johan Dahl] interested in this part of the job will meet me tomorrow. He has been rather optimistic during our previous meetings. (Kristen Nygaard)*[iv]

In the early 1960s, programming language development was something totally new, and Nygaard found it difficult to get the necessary financial support for such a project in Norway. He had to seek funding elsewhere. On a business trip to the United States in spring 1962, he met with representatives of the computer manufacturer Sperry-Rand Univac. The company had just launched a new generation of mainframes known as the 1107, and management was interested in setting up a demo machine in Europe. In a brilliant show of strategy, Nygaard managed to convince Univac that the Norwegian Computing Centre in Oslo would be the perfect place to showcase their new machine, and also that they should take a closer look at his plans for Simula. Robert W. Bemer, then Univac's director of systems programming, recalls:

> *It was just after I started with UNIVAC that I met a Kristen Nygaard of the Norwegian Computing Centre, Oslo. He told me about his Simula project. My yearly budget for Systems Programming was about USD 8 million at that time, and it was to cover the work of roughly 325 people. Five percent of that money was at my discretion to do whatever I thought would benefit UNIVAC most! As chance would have it, I was organising and chairing a session at the IFIP Conference in Munich that August, and Nygaard's project was a close fit. I invited him to give a paper at that session. It caught my interest. I wanted Simula for the 1107 software repertoire. (Robert W. Bemer)*[v]

When he got back from his trip, Nygaard immediately went to the Research Council of Norway and put forward his case for why they ought to purchase the Univac 1107, which was being offered on very favourable terms. The Research Council's director, Robert Major, and the rest of the Board were not hard to convince. The two parties entered into negotiations in the late summer of 1962. During these negotiations, Univac not only offered to sell the 1107 at half-price (MNOK 7.1), but further sweetened the deal by promising to fund the development of Simula.

> *In light of the, shall we say, progressive attitude in Norway at the time (we were rebuilding the country and everyone was very much attuned to doing new things), it was decided that we would purchase this Univac 1107 for the Norwegian Computing Centre. (Karl Holberg)*[vi]

DEVELOPING SIMULA

With the all-important question of funding safely squared away, Dahl and Nygaard could finally begin the actual development of their new programming language. The first version, later known as Simula I, was created in 1963-64. Ole-Johan Dahl explained:

> *Kristen was responsible for the external parts of the project, getting contracts and so forth, while my main responsibility was the implementation of the compiler. We had many discussions about the design of the programming language; Kristen from the point of view of what he felt was necessary in order to make good simulation models, and I from my end, which was based in Algol, about what a decent programming language should look like. (Ole-Johan Dahl)*[vii]

Dahl and Nygaard's original idea was to implement Simula as a simulation package for Algol 60. However, as they delved deeper into the intricacies of implementation, they decided instead to build a Simula compiler from scratch. Consequently, when Simula I was released to Univac in January 1965, it was a complete Algol-based programming language for discrete-event simulations.

The proliferation of new special-purpose programming languages in the 1960s led a growing number of computer scientists to question the direction in which the field was headed. As the decade wore on, the desire for standardisation and unification in language design was most aptly expressed through the notion of the general-purpose programming language. Dahl and Nygaard discovered early on that their simulation language could also be used as a more general programming tool. Inspired by international research on new general-purpose concepts, they soon began to generalise and expand upon the basic concepts of Simula I.

> *Dahl and I started out to make a simulation language, but of course, we have spent so much time with all these people working on general-purpose languages that I must admit we have to some extent fallen in love with the concept of general-purpose languages. (Kristen Nygaard)*[viii]

The new version, known as Simula 67, was first presented by Dahl and Nygaard in 1967. It introduced the world to a whole new way of thinking about programming; a concept known today as object-oriented programming.

THE HERITAGE OF SIMULA

By the mid-1980s, a new paradigm known as object-orientation

Kristen Nygaard held an inspiring speech at the official opening of Simula on 4 April, 2002.The portraits of Nygaard and Dahl were made by the Norwegian artist Hans Normann Dahl.

was beginning to take shape in international computer science. In Norway in general and the University of Oslo in particular, object-orientation was nothing new though. Through the use of Simula as the primary language by which students were introduced to computer science, the University of Oslo had, in fact, taught object-orientation since the early 1970s. Internationally, it was a different story. In the early 1970s, Alan Kay introduced an object-oriented language called Smalltalk. Kay derived the inspiration for his work partly from the first visual drawing program, Sketchpad, by Ivan Sutherland, and partly from Simula, which he had first come across in 1966 as a graduate student in Utah. He explains:

> *In those days, programs were on listings and the engineering building had very long corridors. The way you learned about programs in those days was that you unravelled the listings all the way down the hallway and graduate students would crawl around on them looking at the machine code. After a week or so of that, we discovered that the storage allocator was different than Algol. Then we suddenly realised that this was an algorithmic programming language that has structures like Sketchpad, and then we immediately knew what it was. (Alan Kay)*[ix]

Even though Smalltalk was an important contribution to computer science and, as such, helped plant ideas about object-orientation in the minds of many in the academic research and educational communities, it was nevertheless another language that would convey those ideas to the large, important industrial sector.
By the early 1980s, the C programming language developed by Dennis Ritchie of AT&T's Bell Labs had become very popular in industry, largely due to its close ties to the Unix operating system for which it had been developed. While C itself was not object-oriented, it has nevertheless become an important part of the history of object-oriented programming, thanks to the Danish-born computer scientist Bjarne Stroustrup. Stroustrup had first learned about Simula as an undergraduate student in computer science in his native Denmark. He says:

> *The Simula class concept is not just a programming level concept, it's something that helps you organise your thoughts. I see a program as a model of some view of reality and using structures to organise it. (Bjarne Stroustrup)*[x]

When he later took a job at Bell Labs, Stroustrup began thinking about how he could combine the popular C language with the powerful object-oriented concepts of Simula. His answer was a new language he called C++. Stroustrup's language was seen by many as a derivation of C rather than something completely new. This undoubtedly helped it gain acceptance in the computer industry. While Simula and Smalltalk were the languages that introduced the concepts of object-oriented programming, it was in effect C++ that truly paved the way for object-orientation as a more widely, generally acceptable approach to programming. The Java programming language from the mid-1990s cemented this acceptance and helped bring object-oriented programming into universities as the training language of choice for students. What began as a simple but brilliant idea in the minds of Kristen Nygaard and Ole-Johan Dahl in the early 1960s had become a new paradigm in computer science world-wide.

> *If you look at Simula in hindsight, you can say that it was good. Simula was object-oriented programming. You can see what it is today, but back then we couldn't see that. This vision of what it could be had to be communicated. You had to get people hooked on it, first the very idea of Simula, a system description and what it could be used for. Later, of course, Simula as a language in a much wider sense with all the possibilities that it embodied. (Kristen Nygaard)*[xi]

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A. Karahasanovic, B. Anda, E. Arisholm, S. E. Hove, M. Jørgensen and **D. Sjøberg**: A Think-Aloud Support Tool for Collecting Feedback in Large-Scale Software Engineering Experiments. *Research Report* no. 07, Simula Research Laboratory, 2003.

O. Lysne, J. Duato and T. Pinkston: A Methodology for Developing Deadlock-Free Dynamic Network Reconfiguration Processes. *Research Report* no. 10, Simula Research Laboratory, 2003.

Scientific talks

T. Akbay, **A. M. Bruaset** and **H. P. Langtangen**: A Multi-Physics Solid Oxide Fuel Cell Simulator as a Diffpack Application, *the 21st CAD-FEM User's Meeting*, Potsdam, Germany, November, 2003.

E. Arisholm: Empirical Studies of Pair Programming, *the 11th International Software Engineering Research Network Meeting (ISERN 2003)*, Rome, Italy, 4 October, 2003.

A. M. Bruaset and **H. P. Langtangen**: Future Development of Diffpack at Simula, *the 21st CAD-FEM User's Meeting*, Potsdam, Germany, November, 2003.

M. Dæhlen og G. Hasle: Koordineringsteknologi – IKT og logistikk, *TOP industriseminar*, 13 November 2003.

V. S. W. Eide: Real-time Content-based Video Analysis, *Oregon Graduate Institute*, Portland, Oregon, USA, 7 November, 2003.

F. Eliassen: The QuA project: QoS-Driven Service Planning in an Open Component Architecture, *University of Twente*, June 26, 2003.

F. Eliassen: The QuA project: QoS-Driven Service Planning in an Open Component Architecture, *Orgeon Grauate Institute*, Portland, Oregon, USA, 7 November, 2003.

M. Fimland and **M. Dæhlen**: Resolving inconsistencies in multilevel terrain models with water networks, *Computer Graphics in Norway*, Simula, 3-4 March, 2003.

H. Gallis: Pair Programming versus Individual Programming on Maintenance Tasks with Professional Subjects: A Controlled Experiment, *11th International Software Engineering Research Network Meeting (ISERN 2003)*, Rome, Italy, 4 October, 2003.

J. Hannay: System F and Aspects of Relational Parametricity, Part 1, *Ifi*, Oslo, 21 May, 2003.

J. Hannay: System F and Aspects of Relational Parametricity, Part 2, *Ifi*, Oslo, 31 October, 2003.

J. Hannay: System F and Aspects of Relational Parametricity, Part 3, *Ifi*, Oslo, 7 November, 2003.

M. Hanslien, K. H. Karlsen, G. T. Lines and **A. Tveito**: Stability Conditions for Numerical Methods Applied to Stiff Systems of Reaction Diffusion Equations, *the SIAM Conference on Computational Science and Engineering*, San Diego, 11 February, 2003.

Ø. Hjelle and **M. Dæhlen**: A multi-grid approach to scattered data approximation, *Computer Graphics in Norway*, Simula, 3-4 March, 2003.

A. Karahasanovic: Think-Aloud Tool as a Means for Getting Insights into Learning Object-Oriented Concepts, *Workshop on Learning and Teaching Object-Orientation – Scandinavian Perspectives*, Oslo, 20 October, 2003.

A. Karahasanovic: A Think-Aloud Support Tool for Collecting Feedback in Large-Scale Software Engineering Experiments, *Forskningsseminar Intermedia*, Oslo, 8 October, 2003.

H. P. Langtangen: Challenges in Software Development for Multi-Physics Simulation, *the SIAM Conference on Computational Science and Engineering*, San Diego, February, 2003.

H. P. Langtangen and **O. Skavhaug**: A First Step Towards Automatic PDE Code Verification, *Challenges for High-Performance Simulation for Science and Engineering*, Dagstuhl, Germany, March, 2003.

H. P. Langtangen and **A. M. Bruaset**: The history and Philosophy of Diffpack, *the 21st CAD-FEM User's Meeting*, Potsdam, Germany, November, 2003.

H. P. Langtangen: Stochastic Ordinary Differential Equations and Deterministic Partial Differential Equations -- On the Relation Between Quantum Mechanics and Other Fields of Science, *Workshop Numerical Methods for Quantum Mechanics at the Center of Mathematics for Applications*, Oslo, Norway, November, 2003.

H. P. Langtangen: The Finite Element Method in Physics and Engineering, *talk at Cavendish Laboratory of Physics*, University of Cambridge, November, 2003.

G. T. Lines and **X. Cai**: Parallel Solution Strategies for the Bidomain Model, *the SIAM Conference on Computational Science and Engineering*, San Diego, 10-13 February, 2003.

B. F. Nielsen, G. T. Lines and **A. Tveito**: Determining the size and location of a myocardial infarction; a scientific computing framework, *European Conference on Numerical Mathematics and Advanced Applications*, Prague, Czech Republic, August 2003.

T. K. Nilssen and **L. Ingebrigtsen**: Grid size requirements for simulation of electrical activity in the heart, *the SIAM Conference on Computational Science and Engineering*, San Diego, 11February, 2003.

T. Sevaldrud and **M. Dæhlen**: Multilevel triangulation for real-time rendering, *Computer Graphics in Norway*, Simula, 3-4 March, 2003.

D. Sjøberg: Provocation: Tool support for long-lived experiments and case studies is poor, *11th International Software Engineering Research Network Meeting (ISERN 2003)*, Rome, Italy, 3 October, 2003.

D. Sjøberg: Students versus Professionals as Subjects in Experiments, *11th International Software Engineering Research Network Meeting (ISERN 2003)*, Rome, Italy, 4 October, 2003.

O. Skavhaug: Fully Automatic Method of Manufactured Solutions. *Advanced Environments and Tools for High Performance Computing, EuroConference on Problem Solving Environments and the Information Society*, Albufeira (Algarve), Portugal, 14-19 June, 2003.

T. Skeie: IP-tjenestekvalitet: Integrated Services og RSVP, *Studiemøtet 2003*, Lillehammer 12-13 Juni, 2003.

A. Tveito, G. T. Lines, J. Sundnes, B. F. Nielsen, P. Grøttum, X. Cai, and **K. A. Mardal**: Computing the electrical activity in the human heart, *the European Conference on Numerical Mathematics and Advanced Applications*, Prague, Czech Republic, August, 2003. (invited plenary talk)

A. Tveito, G. T. Lines, J. Sundnes, B. F. Nielsen, P. Grøttum, X. Cai, and **K. A. Mardal**: Computing the heart, *Presented at the 21st CAD-FEM users meeting*, 2003. (invited plenary talk)

A. A. Vazquez and **B. F. Nielsen**: On the convergence of multigrid methods for PDEs in mathematical finance, *the 11th GAMM-Workshop on Multigrid and Hierarchic Solution Techniques*, Leipzig, Germany, August, 2003.

M. Vokác: Practical Use of Design Patterns, *the European Software Engineering Research Network (ESERNET) Scientific Workshop & Experience Day*, Rome, Italy, 4-7 March, 2003.

M. Vokác: A large-scale industrial experiment on software development methodologies, *ESERNET Final Project Review, EU Directorate-General for Information Society*, Brussels, 18 December, 2003.

Å. Ødegård, H. P. Langtangen, K. Hinsen and **O. Skavhaug**: High-level Design of Parallel Libraries Using Python and BSP, *Challenges for High-Performance Simulation for Science and Engineering*, Dagstuhl, Germany, March, 2003.

Å. Ødegård, O. Skavhaug, K. Hinsen and **H. P. Langtangen**: High-level programming with Python and BS, *Challenges for High-Performance Simulation for Science and Engineering*, Dagstuhl, Germany, 11 March, 2003.

Other presentations

B. Anda: An evaluation of the introduction of UML in a large multinational company, *ESERNET/SPIKE seminar*, Norges Forskningsråd, Oslo, Norway, 11 June, 2003.

M. Dæhlen: Utfordringer ved etablering og oppbygging av et forskningssenter, *EPJ-senteret*, 8 Desember 2003.

M. Dæhlen og E. Maartmann-Moe: Såkorn for forskningsbasert nyskaping, *Norsk Venturekapital forening*, 12 November 2003.

M. Dæhlen: Fra Forskning til Forretning – systematisk forskningsbasert nyskaping, *Viten og Verdi*, 5 November 2003.

M. Dæhlen og E. Maartmann-Moe: Såkorn for forskningsbasert nyskaping, *Gründerdagen*, 30 October 2003.

M. Dæhlen: Systematisk forskningsbasert nyskaping – etablering av et «technology transfer office» ved Universitetet i Oslo, *Næringslivsrådet i Oslo og Akershus*, 5 October 2003.

M. Dæhlen: Anvendt forskning mot 2010, *Norsk Regnesentral*, 10 October 2003.

M. Dæhlen og E. Maartmann-Moe: EFFEKT-modellen, Fra forskning til forretning, *Abelia*, 22 May 2003.

M. Dæhlen: Fra forskning til forretning – en konstant vandring i ukjent landskap, *Gründerskolen*, 22 February 2003.

M. Dæhlen og E. Maartmann-Moe: Hvordan stimulere til entreprenørskap blant forskere, *Norsk Venturekapital forening og Abelia*, 5 February 2003.

M. Dæhlen: Systematisk innovasjon (fra forskning), *Norsk Hydro*, 4 February 2003.

M. Dæhlen: Virkemidler for systematisk forskningsbasert nyskaping, *Næringsdepartementet*, 20 January 2003.

M. Dæhlen: Systematisk Nyskaping fra Forskning, *Norges forskningsråd*, 12 January 2003.

H. Gallis: Collaboration on Software Tasks (Pair Programming), *ESERNET/SPIKE seminar*, Norges Forskningsråd, Oslo, Norway, 11 June, 2003.

H. Gallis: Erfaringer fra Parprogrammering i Objectnet, *Abelia Innovasjon Fagkonferanse*, Klækken hotell, Hønefoss, 27 November 2003.

M. Jørgensen: Årsaker til estimeringsfeil, *WM-Data*, Oslo, 28 January 2003.

M. Jørgensen: Software Engineering Research at Simula Research Laboratory, *Universitetet i Bergen*, Bergen, 11March 2003.

M. Jørgensen: Estimering av arbeidsmengde i IT-prosjekter, *Høgskolen i Rena*, Rena, 18 March 2003.

M. Jørgensen: Bruk av sjekklister i IT-prosjekter, *Abelia Innovation Seminar*, Oslo, 1 April 2003.

M. Jørgensen: How to increase the realism of cost estimates in SW development projects, *Opera Software*, Oslo, 2 April 2003.

M. Jørgensen: Software cost estimation, *Opera Software*, Strømstad, 17 June 2003.

M. Jørgensen: Estimering av kostnader i IT-prosjekter, *Arbeidsdirektoratet*, Oslo, 23 September 2003.

M. Jørgensen: Fra usikkerhetsanalyse til usikkerhetshåndtering, *SPIKE*, Fornebu, 22 October 2003.

M. Jørgensen: Usikkerhet i IT-prosjekter, *Abelia Innovasjon Fagkonferanse*, Klækken hotell, Hønefoss, 27 November 2003.

M. Jørgensen: Undervurdering av usikkerhet i IT-prosjekter, *Holte Prosjekter – Frokostseminar*, Oslo, 5 Desember 2003.

E. Maartmann-Moe og **M. Dæhlen**: Standford-modellen, Fra forskning til forretning, *Abelia*, 22 May 2003.

E. Maartmann-Moe og **M. Dæhlen**: Internasjonale «soft-money» mekanismer, *Forskningsparken*, 22 August 2003.

D. Sjøberg: Forskning i software engineering på Simula, *SINTEF*, Norge, 14 March 2003.

A. Tveito: Simulasenteret; hjerteprosjektet og BeMaTa, *Forskermøte i BeMaTA*, Hurdalssjøen, 22 October 2003.

M. Vokác: Practical Use of Design Patterns, *Software Process Improvement based on Knowledge and Experience (SPIKE), SPIKE/ESERNET samling*, Oslo, 11 June, 2003.

Seminars held at Simula Research Laboratory

Computer Graphics in Norway, 4-5 March, 2003.
Organizers: University of Oslo (Prof. T. Lyche), and Simula Research Laboratory (Prof. M. Dæhlen), 20 talks and 58 participants.

Simula Research Laboratory project seminar: Mathematical and numerical modeling of medical ultrasound wave propagation, 3 December, 2003.
Organizers: Simula Research Laboratory, W. Chen and A. Bounaim, 12 external participants, as well as a guest visitor, Prof. Thomas Szabo.

Popularisations

T. Dybå og **M. Jørgensen**: Kunnskapsbasert systemutvikling, del 1 (av 3), *Computerworld Norge*, nr. 30, 6 June 2003.

T. Dybå og **M. Jørgensen**: Kunnskapsbasert systemutvikling: Forskningsbasert kunnskap, del 2 (av 3), *Computerworld Norge*, nr. 31, 13 June 2003.

T. Dybå og **M. Jørgensen**: Kunnskapsbasert systemutvikling: Vurdering av forskning og egen praksis, del 3 (av 3), *Computerworld Norge*, nr. 32, 20 June 2003.

M. Dæhlen og E. Maartmann-Moe: Norges ukjente gullgruve, *Dagens næringsliv*, kronikk, 13 February 2003.

OTHER SIMULA ARTICLES IN MEDIA

«Utdannelse mye viktigere enn erfaring», *Computerworld Norge*, February 2003.

«Lærer mer av skole enn jobb», *Dagsavisen*, March 2003.

«Hvis du trenger it-kompetanse: Formell utdanning viktigere enn erfaring», *HR Norge*, April 2003.

«Mye ubrukt forskning i Norge», *Computerworld Norge*, nr. 27, 16 May 2003.

«Unngå demo-er», *Computerworld Norge*, May 2003.

«Gapet mellom industri og forskning kan tettes», *Computerworld Norge*, May 2003.

«Fornebu-forskning hindre it-skandaler», *Asker og Bærums Budstikke*, May 2003.

«Ofte sprekk i IT-prosjekter», *NRK – Økonomi, nrk.no*, 20 October 2003.

«IT-prosjekter sprekker», *Aftenposten*, 21 October 2003.

«Regn med kaos i store prosjekter», *Computerworld Norge*, October 2003.

Simula on TV: Read the article on page 31.

Doctorates and Master's Degrees in 2003

Doctorates (Dr. Scient)	Supervisors	Thesis	Date
Bente Anda	D. Sjøberg	Empirical Studies of Construction and Application of Use Case Models	April 2003
Kent-Andre Mardal	H. P. Langtangen R. Winther, UiO	Software and Numerical Methods for the Incompressible Navier-Stokes Equations	June 2003

Masters (Cand.scient)	Supervisors	Thesis	Date
Asgeir Johannes Bjørlykke	O. Lysne	Measuring and modeling switched Ethernet Networks	February 2003
Erik Andreas Brandstadmoen	O. Lysne	Modelling the Infiniband Architecture	February 2003
Eskild Busch	M. Jørgensen	Analogy-based expert estimation of software projects	January 2003
Kristian Børresen	M. Dæhlen	Hierarchical modelling and real-time visualization of forrest	December 2003
Morten Wang Fagervang	H. P. Langtangen	Creating interactive, dynamic, visual illustrations for teaching with high-level software tools	November 2003
Siw Elisabeth Hove	E. Arisholm	Planning the introduction of an incremental and component based development process : experiences from a software process improvement project	January 2003
Sigve Høghaug	O. Lysne	Dynamic Sones in interaction with dynamic focus and aura – a study in filtration based on relevance in network based virtual environments	July 2003
Bjørn Egil Jenssen	H. P. Langtangen	Voxel-Based 3D Visualization in OpenGL	April 2003
Anja Kristine Kristoffersen	M. Dæhlen	Terrain models with network constraints – visualization and analysis	May 2003
Amund Kvalbein	F. Davik S. Gjessing	Bridging in RPR networks - Evaluation of an enhanced bridging algorithm	June 2003
Bjørnar Libæk	S. Gjessing	Development of TCP and RED-modules in a Java based Network simulator	June 2003
Kjetil Myhre	S. Gjessing T. Urnes	Policybased networking in a mobile, multiconnected environment	June 2003
Nils Agne Nordbotten	T. Skeie N. Aakvaag	Service Discovery in Bluetooth Scatternets	August 2003
Ståle Wåge Pedersen	H. P. Langtangen	Simulation of Rigid Body Dynamics	June 2003
Tom Røise	M. Jørgensen	A project and organization dependent framework for selection of software cost estimation methods	August 2003
Siri Spjelkavik	H. P. Langtangen	SIC - A Version Control System	June 2003
Petter Teigen	F. Davik S. Gjessing	Topology Discovery in Resilient Packet Ring	June 2003
Thomas Tomter	G. Horn O. Lysne	Measuring voice quality over IP	May 2003
Håvard Wall	X. Cai H. P. Langtangen	Optimization of parallel Diffpack simulations	August 2003
Espen Westgaard Lars Ove Claesson	S. Gjessing	Creating an RPR Simulator	February 2003

Bringing the world of research to the general public

In the summer of 2003, Professor Morten Dæhlen of the Simula Research Laboratory was featured on eight programmes in the Norwegian Broadcasting Corporation's (NRK) TV series «Sommeråpent» (Summer Open). Each individual episode was seen by as many as 550 000 viewers, giving Dæhlen a unique opportunity to talk about research to the general public.

Morten Dæhlen and Kari Nyheim Solbrække.

The series offered an entertaining mix of music, discussions of current affairs, reports from the field and humour, making it one of NRK's most popular summer programmes through the years. Morten Dæhlen had spots in eight of a total of 20 broadcasts, each of which was seen by 400 000 to 550 000 viewers. It is estimated that the eight programmes were seen by about 1 million different viewers, or roughly one-fourth of the population of Norway. Dæhlen's spots covered different fields of research, but the basic idea was to showcase the importance of research in a straightforward, easily understood manner, and to use this good publicity to promote more interest in research *per se*.

The final spot in the series was entitled “Women’s positions of authority in the transition from the industrial to the information society“. Among other things, it addressed the issue of why it is difficult to recruit women to the sciences in Norway. Kari Nyheim Solbrække, a sociologist at the Centre for Research on Women and Gender at the University of Oslo, pointed out that the time-related demands of working life can be difficult to combine with other everyday activities. This affects women in particular since they are often still the primary care-givers in families. It was also interesting to note that those who have the time and capabilities to dedicate to a career often do eventually attain positions of authority. In working life, men take advantage of this to a far greater extent than women. In future, when trying to recruit more women to the sciences, it is important that we have fundamental knowledge about the mechanisms that create such differences between women and men in working life.

The other seven science spots in the series focused, respectively, on interdisciplinarity and weather forecasting, the Internet and traffic jams, HIV research and research-based innovation, the Simula Centre's heart simulation research project, nanotechnology, why there is oil in the North Sea, and the visualisation of large volumes of information.

[simula . research laboratory]

Simula Research Laboratory (Simula) conducts basic research in selected areas within information and communication technology. The main objectives of Simula are to conduct high quality research, educate graduate students and support the establishment of business based on the research it conducts. Hence, all research projects are designed with the potential for application.

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