[simula . research laboratory]

Annual Report
Årsmelding
2001

Content

Managing director

100 years of huge changes

In February 1946 a scientific experiment led to the world's first electronic computer being put into function. Half a century later this presumably marginal invention has changed our society and become an important part of our daily life. What may we expect in the 44 years remaining before the 100th anniversary of the computer?

A new health care service

There is little doubt that information and communication technology (ICT) will play a major role also in the years to come. In 2046 telemedicine will enable medical specialists to treat patients situated in geographically distant locations. High precision robots combined with advanced sensors and measuring devices will improve the ability of medical doctors to perform difficult surgery. Complex computerized analysis gives the doctors critical advice in the treatment of patients. Microsystems based on nanotechnology are placed in the body, allowing blind people to see and physically disabled to walk. Patients may receive treatment in their homes through network-based consultations with their doctor, and medical surveillance equipment in people's homes communicates directly with hospitals.

Intelligent objects

An increasing number of objects – ranging from complex constructions like aeroplanes to simple packaging – are developed and produced using extensive computations. Furthermore, objects will to an increasing extent contain complex computer systems. Cars will be able to observe and act upon events in the traffic,

100 år med store endringer

I februar 1946 førte et naturvitenskapelig forskningseksperiment til at verdens første datamaskin ble bygget og satt i drift. Et halvt hundre år senere har denne oppfinnelsen forandret samfunnet og blitt en viktig del av hverdagen. Hva kan vi vente oss i de 44 årene som gjenstår før datamaskinen er 100 år?

Et nytt helsevesen

I årene som kommer vil telemedisin gjøre det mulig for spesialister å behandle pasienter som oppholder seg på andre geografiske steder. Høypresisjonsroboter koblet med avanserte sensorer og målemetoder forbedrer kirurgens evne til å utføre vanskelige operasjoner. Kompliserte datatekniske analyser gir legene avgjørende råd i behandlingen av pasienter. Det plasseres mikrosystemer (nanoteknologi) i kroppen som kan få blinde til å se eller bevegelseshemmede til å gå. Pasienter vil kunne motta behandling hjemme gjennom nettbaserte samtaler med legen, og medisinsk overvåkingsutstyr i hjemmet kan kommunisere direkte med sykehuset.

Intelligente gjenstander

Stadig flere gjenstander – fra komplekse gjenstander som fly til dagligdagse emballasjer -- utvikles og konstrueres ved hjelp av omfattende bereg-

and our well-equipped kitchen will communicate directly with the local convenience store, and order supplies when needed.

Improved science

Science will be conducted in virtual laboratories, where scientists may collaborate with colleagues all over the world, use instruments wherever they may be situated, share data and computer resources, and exploit knowledge organized in global digital libraries. Through use of computers far more powerful than those available today, future scientists will make new discoveries that are of vital importance to the human race. Possible applications include a detailed mapping of the human brain, and a deep understanding of climatic changes.

Improved understanding of the environment

Advanced computer systems are used to continuously analyze the condition of air, water and soil, based on a number of different measurements. Information is produced that gives precise descriptions of the environmental condition and development of the earth. Through extensive computations we will be able to predict the behaviour of eco-systems, such as changes in temperature, rainfall and atmospheric composition. Large integrated systems give complete analyses of challenges related to climate and environment, which may serve as a basis for political choices leading to a sustainable development.

New ways of trading

During the upcoming years an increasing number of companies will contact their customers over the Internet, get feed-back on their products, and develop customized products or improve existing products based on the feed-back. All financial transactions will be secure, and a large number of purchases will be automated.

"Everyone" can communicate

A billion people will be together in the digital room, the Internet of the future. Here they will take part in electronic meetings, obtain secure handling of all financial transactions, and talk to friends and family all over the world. The communication will be independent of language, because the computer will provide excellent simultaneous translation.

These are a few views of the future, illustrating what ICT may bring in the forthcoming years. Even if some of these events do not happen, and other revolutionary inventions may appear, we may state with great certainty that the computer will change our daily-life also in the future.

Simula Research Laboratory does basic, long-term research on selected areas within ICT. This means that we, together with many other ICT researchers in Norway, take part in shaping our common future. Year 2046 is just around the corner!

Professor Morten Dæhlen, Managing director

ninger utført av datamaskin. Videre vil gjenstander i stadig større grad inneholde avanserte datasystemer. Biler vil kunne observere hva som foregår i trafikken og reagere deretter, mens vårt velutstyrte kjøkken vil kommunisere direkte med «kjøpmannen» og bestille forsyninger etter behov.

Et løft for forskningen

Gjennom bruk av datamaskiner som er langt kraftigere enn i dag, vil fremtidens forskere gjøre nye oppdagelser av vital betydning for menneskeheten. Det kan dreie seg om detaljert kartlegging av den menneskelige hjerne eller dyp forståelse av klimatiske endringer. Forskningen vil foregå i virtuelle laboratorier der forskere kan samarbeide med kolleger verden over, bruke instrumenter der de måtte befinne seg, dele data og datamaskinressurser, og utnytte kunnskap organisert i globale digitale biblioteker.

Dypere miljøforståelse

Avanserte datasystemer brukes kontinuerlig til å analysere en rekke forskjellige målinger av tilstanden i luft, vann og jordsmonn. Det produseres informasjon som gir presise beskrivelser av klodens miljømessige tilstand og utvikling. Gjennom omfattende beregninger kan vi forutsi økosystemers oppførsel ved endringer i temperatur, nedbørsmengde og atmosfærens sammensetning. Store integrerte systemer gir samlede analyser av klima- og miljøutfordringer som grunnlag for myndighetenes utforming av en bærekraftig politikk.

Nye måter å handle på

I løpet av de neste årene vil stadig flere bedrifter henvende seg til kundene over nettet, få tilbakemeldinger, utforme skreddersydde produkter og forbedre produktene basert på tilbakemeldingene. Alle økonomiske transaksjoner vil være sikre, og vi kan automatisere en rekke innkjøp.

«Alle» kan snakke sammen

En milliard mennesker vil kunne "oppholde" seg samtidig i det digitale rom – dvs fremtidens internett. Her vil de delta i elektroniske møter, oppnå en sikker håndtering av alle økonomiske transaksjoner, og snakke med venner og familie over hele verden. Dette vil kunne foregå uavhengig av språk, fordi datamaskinen vil være en glimrende simultanoversetter.

Dette er noen framtidsbilder som illustrerer hva IKT kan bringe med seg i årene som kommer. Selv om noe av dette ikke skjer, og andre revolusjonerende ting vil dukke opp, kan vi med stor trygghet si at datamaskinen også i fremtiden vil endre hverdagen.

Simula-senteret driver grunnleggende langsiktig forskning på utvalgte områder innen IKT. Det betyr at vi, sammen med mange andre IKT-forskere i Norge og utlandet, er med på å forme vår felles fremtid. År 2046 er rett rundt hjørnet!

Report from the board 2001

Simula Research Laboratory was established in January 2001. In the preparation of the national budget for the year 2000, the Parliament decided that a research centre was to be established at Fornebu. The centre, which was later named Simula Research Laboratory, was meant to form the scientific core of the upcoming information technology and knowledge centre located around the old terminal building at Fornebu. The Research Council of Norway was given the responsibility for coordinating the planning and establishment of the research centre, in close cooperation with existing institutions for research and education.

The background for this decision was a debate that started nearly ten years earlier, after the Parliament had decided that the international airport for Oslo at Fornebu was to be closed, and that a new airport should be built at Gardermoen north of Oslo. In the discussion of the future use of the Fornebu-area, a group of private investors suggested to establish a knowledge centre for information and communication technology (ICT) in the area. After a heated debate lasting for several years this idea finally was finally adopted by the majority in Parliament.

Simula Research Laboratory was established January 1st, 2001, when the managing director and the directors for two of the research departments were employed. The director for the third research department joined March 1st.

Establishing the research centre

An important part of the planning conducted by the Research Council of Norway was to decide what type of ICT research should be established at Fornebu, and who that would be given the assignment. An interim board was established. The board appointed a committee, which identified a number of possible research areas for the centre at Fornebu, based on existing ICT research in the Norwegian universities. With these suggestions as basis, the research environments were invited to raise suggestions. A competition with 12 participants followed. The interim board, who lead the process of evaluating the applicants, handed their proposal to the Research Council of Norway in November 2000. Based on the proposal three candidates were chosen, and the Simula centre was given the task of establishing research groups within the areas of Software Engineering, Communication Technology, and Scientific Computing.

The research in Software Engineering is directed at improving and developing processes, methods, and tools for developing large information systems. The Communication Technology department deals with communication in heterogeneous networks, with focus on middleware, distributed systems, networks, and network architecture. The research in Scientific Computing is mainly focused on development of generic software for multi-physics simulations, with particular focus on computing the electrical activity of the heart.

The interim board suggested that the Simula centre would be established as a limited company, owned by the University of Oslo, the Norwegian University of Science and Technology, the University of Bergen, the University of Tromsø, the Norwegian Computing Center. The Research Council approved with this

Styrets beretning 2001

Simula Research Laboratory (Simula-senteret) ble etablert i januar 2001. I forbindelse med behandlingen av statsbudsjettet for 2000 gikk Stortinget inn for at det skulle etableres en forskningsenhet på Fornebu. Denne enheten, som etter hvert fikk navnet Simula-senteret, skulle utgjøre den forskningsmessige kjerne i det kommende IT- og kunnskapssenteret i og omkring Terminalbygningen på Fornebu. Norges forskningsråd fikk ansvaret for å koordinere planleggingen og etableringen av forskningsenheten i samarbeid med eksisterende forsknings- og utdanningsinstitusjoner.

Forhistorien til dette vedtaket var en debatt som startet etter at Stortinget nesten ti år tidligere hadde vedtatt at den internasjonale flyplassen for Oslo på Fornebu skulle nedlegges, og at det skulle bygges en ny flyplass på Gardermoen nord for Oslo. I diskusjonen om etterbruken av Fornebu foreslo en gruppe private investorer at det skulle etableres et IT- og kunnskapssenter på området, og denne tanken fikk til sist sin tilslutning av stortingsflertallet etter en hard debatt som varte i flere år.

Simula-senteret ble satt i drift 1. januar 2001, da administrerende direktør og to ledere for forskningsavdelingene tiltrådte. Lederen for den tredje forskningsavdelingen tiltrådte 1. mars.

Etablering av virksomheten

Et viktig element i Norges forskningsråds planlegging gikk ut på å bestemme hva slags IKT-forskning som skulle etableres på Fornebu og hvem som skulle få oppdraget. Et interimstyre ble oppnevnt. Dette interimstyret nedsatte et planutvalg som med utgangspunkt i eksisterende IKT-forskning ved de norske universitetene plukket ut et antall aktuelle forskningsemner for satsingen på Fornebu. Med dette som grunnlag ble forskningsmiljøene invitert til å komme med forslag. Den påfølgende konkurransen fikk 12 deltakere. Interimstyret, som gjennomførte prosessen med vurdering av søknader og intervjuer med forslagstillerne, leverte sin innstilling til Norges forskningsråd i november 2000. Denne innstillingen førte til at Forskningsrådet plukket ut tre kandidater, og Simula-senteret fikk i oppdrag å etablere forskningsgrupper innen industriell systemutvikling, kommunikasjonsteknologi og «Scientific Computing».

Forskningen i industriell systemutvikling er innrettet mot forbedring og utvikling av nye prosesser, metoder og verktøy for utvikling av store informasjonssystemer. Virksomheten i kommunikasjonsteknologi er innrettet mot kommunikasjon i heterogene nettverk med fokus på mellomvare, distribuerte systemer, nettverk og nettverksarkitektur. Forskningen innen "scientific computing" handler i all hovedsak om problemstillinger knyttet til utvikling av generisk programvare for simulering av elektrisk aktivitet i hjertet.

Interimstyret foreslo også at Simula-senteret skulle etableres som et aksjeselskap med Universitetet i Oslo (UiO), Norges teknisk-naturvitenskapelige universitet (NTNU), Universitetet i Bergen (UiB), Universitetet i

suggestion, and the owners were given the task of naming representatives for the board. The board had their first meeting in December 2000.

The management group of the Simula centre worked thoroughly with planning and recruiting, until the Simula centre was brought into full function August 1st 2001, when a large number of scientists and students joined. Establishing the research departments was the most important task at the Simula centre in 2001, and the board is fully satisfied with the work and the result of the process. At the end of the year the centre had a total of 61 people employed in different positions, out of which about 23 percent were recruited from abroad.

Front row: Linda Ingebrigtsen, Jan Trulsen, Bente Anda, Harald Holm Simonsen. Behind: Odd Gropen, Lars Holden, Eivind Hiis Hauge, Kristen Haugland, Tore Gimse, Morten Dæhlen.

Agreements

The Simula centre is run according to a collaboration agreement between the six owners and the Research Council of Norway. Agreements which regulate the relation between the Simula centre and each individual owner have also been established. A decennial (2001-2010) research agreement has been signed with the government, represented by the Research Council of Norway,

Tromsø (UiTø), Norsk Regnesentral (NR) og Sintef som eiere. Forskningsrådet gikk inn for dette forslaget, og eierne fikk i oppdrag å utpeke representanter til styret. Styret hadde sitt første møte i desember 2000.

Simula-senterets ledergruppe gjorde et grundig og omfattende arbeid med planlegging og rekruttering fram til Simula-senteret ble satt i full drift 1. august 2001, da et stort antall forskere og studenter rykket inn. Etableringen av forskningsavdelingene var den viktigste oppgaven som ble utført ved Simula-senteret i 2001, og styret er godt fornøyd med arbeidet og resultatet av prosessen. Ved utgangen av året hadde senteret til sammen 61 ansatte i ulike stillinger, hvorav ca. 23 prosent var rekruttert fra utlandet.

Avtaler

Simula-senteret drives i henhold til en samarbeidsavtale mellom de seks eierne og Norges forskningsråd. I tillegg er det utarbeidet rammeavtaler som regulerer forholdene mellom Simula-senteret og hver enkelt eier. Simula-senteret har også inngått en 10-årig (2001-2010) forskningskontrakt med myndighetene representert ved Norges forskningsråd. Simula-senteret skal evalueres etter 5 år. Utover dette har hver avdeling i Simula-senteret avtaler med Institutt for informatikk (IFI) ved UiO som omhandler undervisning og veiledning av hovedfagstudenter. Grunnen til dette er at kjernen av forskere ved Simula-senteret har permisjoner fra sine stillinger ved IFI. Styret er også godt fornøyd med at Simula-senterets forskningsavdelinger gjennom 2001 har etablert og forsterket samarbeidet med forskere og forskningsmiljøer hos alle eierne.

Administrasjon og infrastruktur

I 2001 var Simula-senteret organisert som et prosjekt ved UiO, i påvente av overgangen til aksjeselskap i 2002. Simula-senteret mottok administrativ støtte fra Institutt for informatikk, fra administrasjonen ved Det matematisk-naturvitenskapelig fakultet og fra UiOs sentrale administrasjon. Styret er gjennomgående godt fornøyd med den administrative støtten fra UiO, og samarbeidet mellom Simula-senterets ledelse og de forskjellige enheter ved UiO har fungert godt.

Simula leide lokaler av UiO og Forskningsparken i Oslo i 2001, og flyttet i midten av desember inn i nye lokaler på Fornebu. Simula har hele tiden vært tilkoblet UiOs IT-infrastruktur og nettverk, også etter flyttingen til Fornebu. Simula har valgt Universitetets senter for informasjonsteknologi (USIT) som driftsoperatør for nettverk, telefoni og maskinpark. Regnskapet for Simula-senteret ble i 2001 gjort opp som et prosjekt ved Universitetet i Oslo. Simula-senteret etablerte i løpet av høsten 2001 sin egen administrasjon og belaster ikke UiOs administrasjon etter flyttingen til Fornebu.

Nye lokaler på Fornebu

Terminalbygningens eier, IT Fornebu Eiendom AS, benyttet Aviaplan AS i utviklingen av lokalene. Aviaplan AS utarbeidet planer for lokalene i hen-

stating that the Simula centre is to be evaluated after five years. Apart from this, each department of the Simula centre has its individual agreement with the Department of Informatics at the University of Oslo, concerning teaching and supervising graduate students. The reason for this is that many of the researchers at Simula are on leave from their positions at the Department of Informatics. The board is pleased to observe that throughout 2001 the research departments at Simula have established and strengthened the cooperation with researchers and research environments representing all the owners.

Administration and infrastructure

In 2001 the Simula centre was organised as a project at the University of Oslo, awaiting the establishment as a limited company. The Simula centre received administrative support from the Department of Informatics, from the administration at the Faculty of Mathematics and Natural Sciences, and from the central administration of the University of Oslo. The board is completely satisfied with the administrative support from the University of Oslo, and the collaboration between the Simula centre and the different units at the university has worked well.

In 2001 Simula rented offices from the University of Oslo and Oslo Innovation Center, until the new offices at Fornebu were finished in December. Even after moving to Fornebu, Simula has been connected to the network and information infrastructure at the university. The university's Center for Information Technology was chosen to run the network, phones and computers. The accounts for Simula in 2001 were audited as a project at the University of Oslo. During the autumn 2001 Simula established its own administration, and does no longer rely on administrative support from the university.

New offices at Fornebu

The owner of the terminal building, IT Fornebu Eiendom AS, used Aviaplan AS in the development of the localities. Aviaplan AS established plans for the localities according to simple specifications made by the Simula centre. Simula was continuously informed by Aviaplan AS about the development of the office plan throughout 2001. Simula was very pleased with this collaboration, and chose to hire Aviaplan AS as consultants for furnishing the offices. The view of the board is that Simula has got functional offices in a simple style.

According to the resolution in the parliament Simula is to be located at the information technology centre at Fornebu. Hence the centre moved into the new offices in the terminal building at Fornebu as soon as they were finished. The moving was December 13th 2001. However, Simula has not come to agreement with IT Fornebu Eiendom on the terms of the rental agreement.

The name of the centre

Following a suggestion from the administration, the board decided to name the centre Simula Research Laboratory. In addition to announcing that the centre is a research laboratory, the name reflects a major Norwegian scientific achievement: the development of the programming language Simula at the Norwegian Computing Center in the early 1960s. This work was done by Kristen Nygaard and Ole-Johan Dahl, who were later appointed professors at the Department of Informatics. Nygaard and Dahl were recently awarded both the A.M. Turing Prize for 2001 and the John von Neumann Medal for 2002, for the development Simula and object orientation. The two awards are the closest you get to a Nobel Prize in informatics, and are awarded by The Association for Computing Machinery (ACM) and The Institute of Electrical and Electronics Engineers (IEEE), respectively.

Other work done by the board

The board of the Simula centre had its first meeting in December 2000. Including this meeting the board has had 4 meeting with a total of 36 cases up for discussion during 2001. Naturally, the board has focused on the work with establishing the centre, including the follow-up of the parliamentary resolution, and the preparation of all the necessary agreements. On the board meeting in June 2001 the board appointed a Scientific Advisory Board for Simula Research Laboratory.

hold til en enkel romplan og tekniske spesifikasjoner utarbeidet av Simula-senteret. Aviaplan AS holdt Simula-senteret løpende orientert om utviklingen av planen gjennom hele 2001. Simula-senteret var meget godt fornøyd med dette samarbeidet og engasjerte derfor Aviaplan AS som konsulenter i arbeidet med interiøret. Det er styrets oppfatning at Simula-senteret har fått funksjonelle lokaler utferdiget i en nøktern stil.

Simula-senteret skal i henhold til stortingsvedtaket lokaliseres i IT- og kunnskapssenteret på Fornebu, og flyttet derfor inn i nye lokaler i Terminalbygningen på Fornebu så fort disse var klare. Flyttingen skjedde den 13. desember 2001. Simula-senteret lykkes imidlertid ikke å komme til enighet med IT Fornebu Eiendom AS om betingelsene i leieavtalen i løpet av 2001.

Navnet på senteret

Etter forslag fra administrasjonen vedtok styret på sitt første møte i desember 2000 at senteret skulle hete Simula Research Laboratory. I tillegg til å fortelle omverden at dette er og skal være et forskningslaboratorium, henviser navnet til en stor norsk forskningsbragd: Utviklingen av objektorientering og programmeringsspråket Simula ved Norsk Regnesentral på 1960-tallet. Dette arbeidet ble utført av Kristen Nygaard og Ole-Johan Dahl, som senere ble professorer ved IFI. Nygaard og Dahl ble nylig tildelt både A.M. Turing-prisen for 2001 og John von Neumann-medaljen for 2002 for utviklingen av Simula og objekt-orientering. De to utmerkelsene er det nærmeste man kan komme en nobelpris i informatikk, og utdeles av henholdsvis The Association for Computing Machinery (ACM) og The Institute of Electrical and Electronics Engineers (IEEE).

Styrets øvrige arbeid

Simula-senterets styre hadde sitt første møte i desember 2000. Inkludert styremøtet i desember 2000 har styret hatt 4 møter med til sammen 36 saker til behandling i løpet av 2001. Styret har i sitt arbeid naturlig nok lagt stor vekt på arbeidet med etableringen av senteret, herunder oppfølging av Stortingets vedtak, og utarbeiding av senterets samlede avtaleverk. Styret oppnevnte et vitenskapelig råd (Scientific Advisory Board) for Simula-senteret på sitt styremøte i juni 2001.

Financial statement 2001

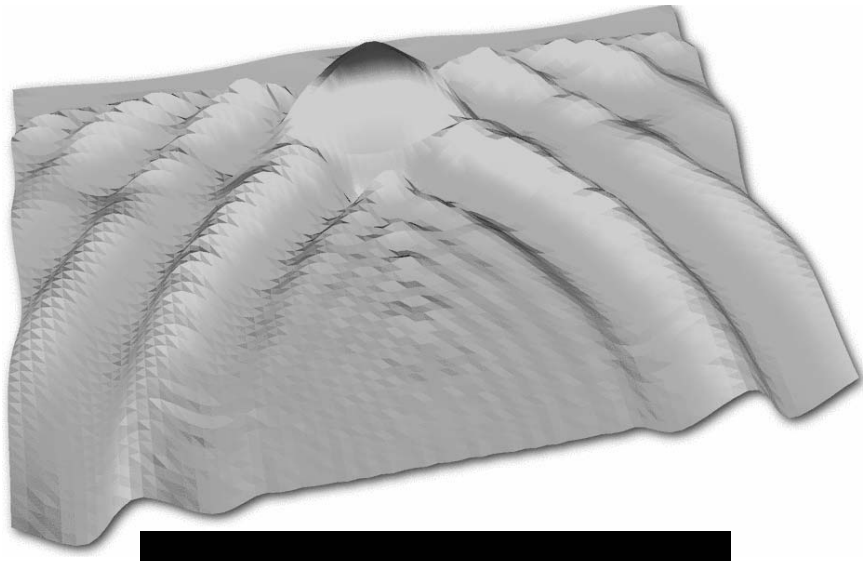
Årsregnskap 2001

In 2001 Simula was organized as a project of the University of Oslo. The accounting for this year therefore is presented as a pure income and expense statement. The University of Oslo has delivered a detailed set of accounts to the Research Council of Norway.

I 2001 var Simula organisert som et prosjekt på Universitetet i Oslo. Regnskapet for dette året er derfor et rent driftsregnskap. Universitetet i Oslo har levert detaljert regnskap til Norges forskningsråd.

Expenses *(Utgifter)*	**1000 NOK**
Salaries and benefits *Lønn og sosiale kostnader*	8 438
Office rental *Leie av lokaler*	1 745
Equipment purchase *Innkjøp av utstyr*	6 617
Operating costs *Driftskostnader*	7 117
Interest costs *Rentekostnader*	10
Total expenses *Sum*	23 927
Income *(Inntekter)*	
Carried forward from 2000 *Overført fra 2000*	13 512
Basic funding *Grunnbevilgning 2001*	20 000
Total income *Sum*	33 512
Profit for the year (carried forward to 2002) *Årsresultat (overført til 2002)*	9 585

Computer simulations improve our understanding of the heart



Researchers at Simula Research Laboratory are in the process of refining a computer simulated model of the electrical activity in the human heart. The heart simulations open possibilities for a number of future applications, such as educating medical students, testing heart drugs and more reliable detection of infarctions with ECG signals.

The human heart consists of billions of cells, which contract, relax again, and influence the neighboring cells for every single heart beat. A research group at Department of Informatics at the University of Oslo has developed a simulated heart that shows how the electrical activity spreads in the form of electrical signals in the heart, and from the heart muscle out to the surface of the body. The researchers at Simula Research Laboratory are currently refining this simulator, to obtain new knowledge about how different heart conditions may be simulated and visualized.

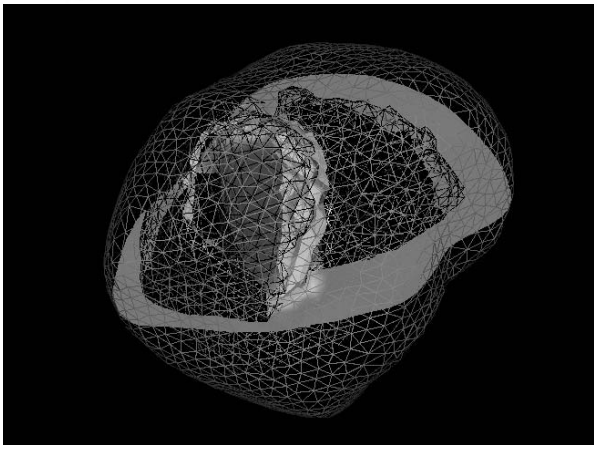
Several international research groups work with simulating the electrical activity of single heart cells or the complete heart muscle. The main motivation is the ability to conduct systematic studies of macroscopic consequences of altered cellular physiology in the heart. The main focus of the researcher at Simula is to develop efficient software that simulates the complete process of electrical activation, from cell to body. The ambition is to become internationally leading within the field.

Difficult to detect with ECG

Almost 50 percent of certain types of infarctions are not detected by traditional ECG. An improved heart simulator may aid the development of better patterns for placing the ECG electrodes, to enable detection of infarctions in more patients and with a higher level of accuracy than today. It may also become possible to study the relationship between different ECG disturbances and changes related to angina pectoris or use of medication.

The simulated heart consists of a set of differential equations, describing how the electrical pulses controlling the heart travel through the heart muscle. The model enables the introduction of an artificial infarction at a certain location in the heart, to study the resulting changes in the electrical pulses.

The basis for the research project "Simulating the electrical activity of the heart" is the electrical properties of the heart muscle cells. Cells that are stimulated in certain ways respond by changing their electrical charge for a short time period, before returning to the normal state. Nerve cells use this change in charge for communication, while in muscle cells it initiates the contraction, and the signal is also passed on to neighboring cells. In the heart this gives rise to a chain reaction of electrical activation and contraction, starting in a number of points around the heart muscle. The result is that a relocation of charge occurs throughout the heart muscle for each heartbeat. Because the heart is connected to the rest of the body, the result of the electrical variations in the heart may be recorded on the body surface. This is the foundation for the use of ECG measurements to identify the condition of the heart. The locations of the ECG electrodes have remained unchanged for many years, and it is not certain that these locations are optimal for acquiring information about the heart.



The foundation for the research project "Simulating the Electrical Activity of the Heart" is the electrical properties of the heart muscle cells. (Illustration: Glenn Lines)

Large simulations

Heart simulations are typical tasks for powerful computers,

because the activity of the heart must be described in terms of complex differential equations with a large number of unknown quantities. At Simula Research Laboratory a model with 32 states in each spatial point is used, and the computation must be performed for several millions of points in the heart muscle and the surrounding tissue. Furthermore, all these states must be computed at thousands of different time points, to describe the propagation of the electrical pulse. This type of problem can only be solved by using numerical methods, well-structured software and powerful computers. Even with the computational resources at Simula, the heart simulations are so demanding that the computers need several days to compute just a single heartbeat.

Developing efficient algorithms is an important part of the research. An important goal is to develop so-called optimal methods, i.e. methods where the computational work only increases proportionally with the number of unknowns. In this work the researchers at Simula have come a long way. Another challenge is to make the simulator code run efficiently on parallel computers, which will be necessary in order to get the required time for the computations down to an acceptable level.

Differential equations were first used to describe cellular activity in the 1950s, in a model for a squid nerve cell. The models have later been refined and extended to other species, including humans. Differential equations are also commonly used to describe mathematical relations in nature, for instance in climate research and meteorology.

The project team consist of Dr. Glenn Lines, professor Aslak Tveito of the Department of Informatics (currently Simula), professor Per Grøttum of the Faculty of Medicine at the University of Oslo, PhD student Joakim Sundnes and cand. scient. Monica Hanslien.

Scientific problems expressed as mathematical models

Scientific computing is about using computers to solve scientific problems expressed as mathematical models. In fact, the prime motivation for developing the first electronic computers was the need to analyse mathematical models of physical phenomena. Today, high performance computing is of fundamental importance in most branches of science and engineering, and it can be viewed as a third paradigm of science alongside models and experiments. Often, projects in the natural sciences involve the following basic ingredients:

1. Physical phenomena
2. Mathematical models
3. Numerical methods
4. Software
5. Simulations
6. Visualizations

In this schematic form, scientific computing covers the steps 3-6. The research in the Scientific Computing Department at the Simula Research Laboratory focuses on the development of numerical methods and software for solving partial differential equations. Such equations are used to formulate the laws of Nature. Our aim is to develop efficient, reliable, and maintainable software addressing mathematical models based on partial differential equations. Our activities can be grouped in three main categories:

1. Scientific Software:
In this area, the main issue is how to develop numerical software. In particular, the software should be well suited to modern parallel computers. The group has participated in the development of a comprehensive software library, Diffpack, for the numerical solution of partial differential equations.

2. Applications in Medicine:
The department is involved in three projects concerning applications of partial differential equations in computational medicine:
- Computing the electrical activity in the human heart
- Computing the flow of blood in the left ventricle
- Computing ultrasound wave propagation

3. Numerical Methods:
The department is involved in the development and analysis of numerical methods for applications in reservoir engineering, computational finance, and fluid flow.

Professor Aslak Tveito, Research Director

Real-time surveillance of images, video and sound

There is a large demand for software capable of analysing sound and images continuously, to be able to sort out interesting events. Researchers at Simula Research Laboratory are about to develop a system which may be used for identification and indexing of multi media information in real-time. This means that the future may look brighter for news addicts, and darker for bank robbers in stolen cars.

Automatic surveillance of sound and images, to discover and categorise particular events, will become a very wide-spread application of computers in the future. However, if you want to keep track of the news broadcasts from tv stations worldwide, searching for information on a specific subject, it is unrealistic to store all the broadcasts digitally for later analysis with a search engine. The amount of information is simply too large. Instead, the computers must be capable of analysing multi media information in real-time, and sort out and store the information that seems interesting. Thereafter you can sit down quietly and watch the news that was picked out based on your predefined search criteria.

The Simula Research Laboratory works with these topics in the research project Distributed Media Journalling (DMJ), where one aim is to develop a framework that may be used for different forms of surveillance of multimedia information.

Hunting for bank robbers

The approach of the Simula Research Laboratory is unique in that the researchers want to develop a framework that is supposed to be usable for new applications as they become available. The framework is a system where it will be possible to include more and more search algorithms. We do not work specifically in the development of new algorithms, but are more concerned with developing a system which may combine several algorithms.

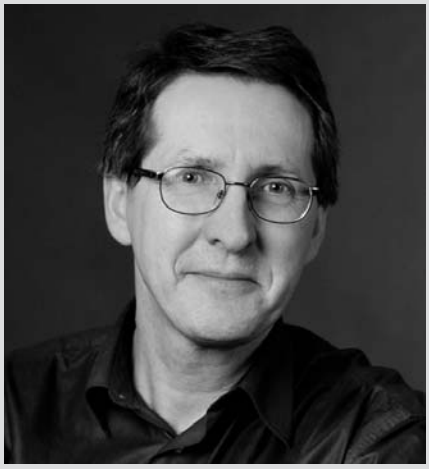
The police in a big city may want a surveillance of all the cameras along the main roads, with an automatic alarm if a yellow car know to be driven by bank robbers passes a camera. In practice computers are not able to check the license numbers of all the passing cars, so they will first have to scan the pictures from the surveillance cameras with an algorithm searching for the phenomenon "yellow car". If a yellow car is spotted the computer may for instance start a new algorithm, designed to sort out the regular cars from trucks, buses and other vehicles. The last algorithm to be activated may be capable of recognizing letters and numbers in the area defined by an earlier algorithm to be the licence plate. The logic of the whole operation is that the most demanding operations are only activated if it is likely that they will give useful information. If all the algorithms

The Communication Technology Department:

Developing the infrastructure of the Internet

The Communication Technology Department studies the communication infrastructure, or the backbone of the information society. The infrastructure is the sum of all the computers and devices that are connected through the Internet. Its functionality and quality is, to an increasing extent, necessary for the function of modern societies.

The department studies network architectures and distributed systems. Our research focuses on open and adaptive middleware, Quality of Service (QoS) management, QoS based routing, network architectures, and performance evaluation through simulations. We believe these technologies are needed to manage heterogeneity in networks, services, end-systems, and applications. The long term goal is to determine the next generation of architectures and platforms for open, dynamically adaptable distributed systems.



Professor Frank Eliassen, Research Director

Our research can be grouped under three main activities:

- Adaptable middleware (Flexiware)

This activity addresses the development and application of new architectures for distributed systems, constructed from the beginning with adaptivity in mind. Middleware platforms for distributed systems and applications are given particular attention. The most important challenges to be addressed are problems related to heterogeneity in networks,

were to be activated at the same time, the system would probably not be able to analyze the first yellow car before the next one would appear.

Analysis in 40 milliseconds

Real-time analysis imposes strict requirements on how much time that may be used to analyse for instance each picture in a television broadcast. The system must use less than 40 milliseconds to determine the contents of a displayed image. The framework developed by the DMJ researchers works as a statistical decision algorithm applied to image processing, where the system continuously performs a large number of calculations to determine the most likely content of the image.

The Simula researchers are developing a flexible system where the computational work may be divided between several computers. On hand-held computers with very limited computational resources, simple analysis algorithms may be used, while more reliable and resource demanding algoritms may be run on powerful computers in a network. There exist a large number of possible applications for Distributed Media Journalling, including for instance new, more advanced web searches, automatic reports on interesting events in road traffic, or scanning of large ocean areas to search for oil spills.

Is there a yellow car with bank robbers in the picture? Researchers at Simula are about to develop a system for real time analysis and indexing of multimedia information.

Aims and financing

The goal for the project is to develop a framework that makes it easier to develop applications for real-time analysis of images, video and sound, where the processing may be adapted to and divided between the available computers. A prototype has been developed and used for implementing a test application. The functionality offered by the framework includes a set of tools that enables creating reusable components for analysis, which associate content with key words or key word components.

The project is financed by The Research Council of Norway through the program Distributed IT systems (DITS).

end-systems, services and applications, and differentiated quality of service provisioning to applications in light of ubiquitous computing and ad-hoc networking.

● Network architectures (I-lab)

This activity focuses on the challenges of providing differentiated services in the Internet in light of important developments such as increasing level of heterogeneity in the network and a wider range of requirements to quality of service for network based applications. The overall goals of this activity is to provide knowledge on how the design of low-level protocols and network components influence overall network performance, in particular with respect to service levels, and to contribute to the realisation of the ambition to provide true service guarantees from complex and possibly heterogeneous network infrastructures.

● Ubiquitous middleware

This activity focuses on extending the scope of middleware to include the network. The goal is to develop a programming model and corresponding API accessible at the middleware level that allows applications to inject into network nodes application, host or subscriber specific processing of network packets as part of multiparty bindings. Such a middleware provides a uniform approach to for example system management at all architectural levels of a distributed systems.

A City center during rush hour

The Internet may be compared to a city centre where the road traffic occasionally is so dense that traffic jams occur. During rush hour it is hard to guarantee that the ambulances will arrive on time, and similarly it is hard to ensure that important information packages arrive through the Internet systems without delays. The need for improving the traffic systems is hence critical. Possible improvements may come from the development of fully optical networks and better systems for network integration and administration.

Associate Professor Erik Arisholm and Professor and Research Director Dag Sjøberg conducted the largest controlled empirical design experiment that has ever been conducted. (Photo: Yngve Vogt, Computerworld)

Empirical experiments give new insight

In November 2001 a total of 130 professional system designers from nine consulting companies took part in the largest controlled empirical design experiment that has ever been conducted. The professional designers were supplemented by 60 students who also participated in the experiment. The purpose was to compare two different design principles, one that has been recommended by the gurus of information and communication technology (ICT), and another that has been considered poor design.

The ICT community contains many established views on which type of computers, programs, design solutions, tools and work methods that are best. The Software Engineering Department at Simula Research Laboratory challenge these established truths by exposing them to empirical tests, and so far the experience shows that many "truths" will hardly stand the light of day.

Preliminary analysis confirms that it is important to conduct this type of experiment in the industry, with professional software developers. The results from the industry will often be different from those obtained from student environments, probably because the industry is a much more divided group than the students. For instance, some professionals are nearly fresh out of school, while others have been in the business for 30 years or more.

The variations in the results from the industry also make the analysis more complicated. The different backgrounds of the participants seem to be important for what type of design that they prefer. On the other hand, most of the students completed the experiments in two to three hours, while the industry consultants used from three to eleven hours, but in that time many of them had also implemented and tested the solution.

Technologies and solutions are rarely evaluated

Regardless of the fact that information and communication technology has grown to a multi-billion dollar industry, amazingly little attention is given to evaluating the many technologies and solutions that have been developed: The Software Engineering Department therefore focuses their efforts on developing new methods for evaluation. The long-term goal is to contribute to the development of new techniques and methods, which may give society more efficient, economic and user-friendly applications.

The new focus on evaluation of software and design solutions is groundbreaking because computer science is still a young field, where the main focus so far has been on technology and development work, without giving much attention to self-exami-

nation. The origin of the field also plays a role, having developed from electronics and mathematics communities where with no tradition for including social sciences in the analyses. However, today personnel expenses often constitute 80-90 percent of the total costs of developing new computer systems, so it is obvious that knowledge of people and organizations is at least as important as the technological knowledge.

The researchers at Simula participate in an international collaboration involving research communities focusing on experimentation related to software development. Particular focus is put on experimenting with development technologies in different environments, repetition of the experiments across community borders, and development and exchange of methods for model building, experimentation and evaluation.

The Software Engineering Department:

Challenging the established truths

The community of information and communication technology contains large numbers of established views on which software development methodologies, tools and languages that are best. The Software Engineering department challenges these truths by exposing them to empirical tests, which show that many of the established truths hardly stand the light of day.

Despite the fact that information and communication technology has long ago grown to a multi-billion euro industry, amazingly little attention has been given to evaluating the many technologies and solutions that have been developed. The Software Engineering department thus focuses their research on developing new methods for evaluation. The long-term goal is to contribute to the development of new software technology that may give society more efficient, economic and user-friendly applications.

The researchers at Simula Research Laboratory take part in an international collaboration between research groups focusing on experiments related to software development. Particular focus is put on experimenting with technologies used in different development communities, replication of experiments across the borders of these communities, and development and exchange of methods and tools for model construction, experimentation and evaluation.

The basic research in the Department of Software Engineering focuses on models, methods, techniques and tools for systems development in an industrial context and empirical research methods for validation of such technology, including case studies and controlled experiments. The group is concerned with technical, organizational and human issues that affect systems development processes. The main goal is to extend the empirically based knowledge about the effect of different models, methods, techniques and tools on processes and products. The research is focused around three research themes:

Object-oriented analysis and design

OO technology is often used in combination with component-based development processes and processes that support change (incremental and evolutionary development). Included in this work are OO metrics (e.g. dynamic coupling), UML use cases, design principles, design patterns, class and schema evolution in OO systems, etc.

Planning, estimation and risk analysis

Companies that develop software notoriously exceed time and cost budgets. Poor estimation, planning and risk analysis often lead to unsatisfactory quality of the delivered product, dissatisfied customers and frustrated developers. The conducted research aims to both improve existing models and developing new models, processes and tools for estimation, planning and risk analysis of software projects.

Process improvement and product quality

To improve the process of software development in companies and organizations, weaknesses must be identified and changes initiated. The group focuses on adaptations and introductions of development processes. Other important issues are experience databases and learning organizations.

De omnimus dubitandum est, said the Danish philosopher Søren Kierkegaard. Everything is to be doubted, and that is exactly what they are doing in The Software Engineering Department.

Research projects at The Simula Research Laboratory in 2001

Scientific Computing

Computational Geoscience
We are involved in several projects regarding partial differential equations (PDE) based models in geologi and geophysics, where we collaborate with university groups and research institutes like The Norwegian Geotechnical Institute.

Generic Software for Partial Differential Equations
The project will focus on the development of modern generic software for solving PDEs.

Mathematical and numerical modeling of medical ultrasound wave propagation
This project aims to address the challenging issues facing medical ultrasound propagation simulation, in particular, relating to some new clinical techniques.

Multi-Physics Models by Domain Decomposition Methods
In this project we want to develop numerical methods and software tools that make it easier to implement multi-physics simulators.

Numerical Algorithms and Software for Parallel Solution of Partial Differential Equations
In this project we want to develop numerical algorithms, reliable and efficient software tools and new simulators suitable for parallel computing. We shall also investigate how the efficiency of communication and computation of a multiprocessor computer influences the overall computing time for challenging simulations.

Numerical Methods for Option Pricing
The purpose of this project is to derive numerical methods and software for solving partial differential equations modeling the the fair price of various financial derivatives.

Scientific Computing Using a Linux-Cluster: Diplopodus
Our main objective is to study what kind of applications are suitable for clusters of linux-based computers for numerical computations.

Scripting Techniques for Scientific Computing
The primary purpose of the project is to help scientists and engineers working intensively with computers to become more productive, have more fun, and improve the reliability of their work. Scripting can be a key tool for reaching these goals.

Simulating the Electrical Activity of the Heart
An increased understanding of the behaviour of the electrical activity of the heart during normal and pathological conditions could improve the diagnostic power of electrocardiogram. Performing realistic simulations requires both massive computer power and the development of efficient numerical software.

Simulation of the Diastolic Left Heart
The aim is to increase the understanding of the relation between the elastic properties of the heart muscle and the flow pattern in the left heart.

Visualization and Graphical Data Modelling
As more and more data are being generated or captured, graphical data modelling and visualization has become more important in order to understand data and processes. In addition to flight simulation, we mainly perform tests on spatial data (scattered terrain data and raster images) and data from medical simulation.

Software Engineering

ESERNET
ESERNET (IST-2000-28754) is a "Network of Excellence"-project under the 5th EU framework program. The project will support and conduct academic and industrial experiments in software engineering, for instance related to object oriented development, inspections, testing and component based development.

Incremental and component-based software development (INCO)
The primary goal is to advance the state-of-the-art and -practice for incremental and component-based software development. This includes developing or improving existing methods, models, techniques and guidelines for such development.

PROcess improvement For the IT industry (PROFIT)
The main goal for PROFIT is to increase the competitive ability of existing software-intensive activities, and to build a foundation for new knowledge based software activities.

Inter-PROFIT
The main goal for inter-PROFIT is also to increase the competitive ability of existing software-intensive activities, and to build a foundation for new knowledge based software activities. Additionally, an important aspect of this project is to do collaborative research projects in international networks, and with foreign or global companies.

Communication Technology

Academic OPNET Research and Education Projects
Four projects sponsored by OPNET Technologies Inc.:

1. Improving Server-network Performance and Reliabilty with Focus on TCP/IP Protocol
2. Performance Evaluation of a Ring Based Ethernet-Like Communication Network
3. InfiniBandTM Architecture Experimental Platform
4. Providing Quality of Service in the Data Link Layer

Distributed Media Journalling: Real-time surveillance of images, video and sound
The aim is to develop a framework that may be used for easy development of different forms of real time surveillance of networked multimedia information.

ENNCE - Enhanced Next-Generation Networked Computing Environment

This project addresses key technical and application issues related to time-critical messaging and multimedia communications by next generation interactive, multimedia middleware services spanning Internet, Intranet, and mobile services, and related to techniques for seamless networking in highly heterogeneous environments

NetSim

This project evaluates different Internet protocols using the NS network simulator. We have developed an NS-based simulation model of PIM-SM tree recovery and evaluated the Inter-Domain Multicast Protocols MSDP and BGMP.

QoS Beans: Introducing Quality of Service Management into Enterprise Component Architectures

The goal of this project is to develop a component server architecture that builds on the flexibility of reflective enterprise component models to provide levels of quality of service guarantees in heterogeneous and dynamically changing distributed environments.

Resilient Packet Ring (RPR)

Researchers at Simula Research Laboratory play an important role in the development of the future regional communication network RPR (Resilient Packet Ring) by performing computer simulations of the new network before it is built.

Publications in 2001

Publications in journals (with review)

E. Arisholm, D. Sjøberg and M. Jørgensen:
Assessing the Changeability of two Object-Oriented Design Alternatives - a Controlled Experiment
Empirical Software Engineering, 6(3), September 2001, pp 231-277

W. Chen and M. Tanaka:
Dual reciprocity BEM applied to transient elastodynamic problems with differential quadrature method in time
Computer Methods in Applied Mechanics and Engineering, 190, 2331-2347

W. Chen and M. Tanaka:
Coupling dual reciprocity BEM and differential quadrature method for time-dependent diffusion problems
Applied Mathematical Modelling, 25, 257-268

W. Chen, C. Shu, H. Xue and H. Du:
Numerical Study of Grid Distribution Effect on Accuracy of DQ Analysis of Beams and Plates by Error Estimation of Derivative Approximations
Int. J. of Numer. Methods Engng., 51(2), 159-179

W. Chen:
Orthonormal RBF Wavelet and Ridgelet-like Series and Transforms for High-Dimensional Problems
Int. J. Nonlinear Sci. & Numer. Simulation, 2(2), 163-168

W. Chen and W. He:
A note on radial basis function computing
Int. J. Nonlinear Modelling Sci. & Engng., 1, 59-65

W. Chen and M. Tanaka:
A meshless, integration-free, and boundary-only RBF technique
Computers & Mathematics with Applications, vol 180, 2331-2347

Ø. Holmeide and T. Skeie:
S. Synchronization
Industrial Ethernet Book, vol. 7, September 2001, pp 26-29

Ø. Holmeide and T. Skeie:
VoIP Drives Realtime Ethernet
Industrial Ethernet Book, vol. 5, March 2001, pp 24-27

M. Jørgensen and D. Sjøberg:
Impact of Effort Estimates on Software Project Work
Information and Software Technology, 43, 939-948, 2001

M. Jørgensen and D. Sjøberg:
Software Process Improvement and Human Judgement Heuristics
Scandinavian Journal of Information Systems, Vol. 13, pp. 99-122, 2001.

H.P. Langtangen and O. Munthe:
Solving Systems of Partial Differential Equations Using Object-Oriented Programming Techiques with Coupled Heat and Fluid Flow as Example
Transactions on Mathematical Software, vol 27, 1-26

T.K. Nilssen, X.-C. Tai and R. Winther:
A robust Nonconforming H2-Element
Math. Comp. Vol. 70, pp. 489-505

J. Sundnes, G. Lines and A. Tveito:
Efficient solution of ordinary differential equations modeling electrial activity in cardiac cells
Mathematical Biosciences 172, pp 55-72

Papers in proceedings

B. Anda, D. Dreiem, D. Sjøberg and M. Jørgensen:
Estimating Software Development Effort Based on Use Cases - Experiences from Industry
In M. Gogolla, C. Kobryn (Eds.): UML 2001 - The Unified Modeling Language. Modeling Languages, Concepts, and Tools, 4th International Conference, Toronto, Canada, October 1-5, 2001, LNCS 2185 Springer-Verlag, pp 487-502

B. Anda, D. Sjøberg and M. Jørgensen:
Quality and Understandability in Use Case Models
In J. Lindskov Knudsen (Ed.): ECOOP 2001 - Object-Oriented Programming, 15th European Conference, Budapest, Hungary, June 18-22, 2001, LNCS 2072 Springer-Verlag, pp. 402-428.

A. Bounaim:
On the use of iterative Schwarz methods in the solution of an optimal control problem
Proceedings from 13th international conference on Domain Decomposition Methods, p. 327-334, CIMNE, UPS, Barcelone

L. Bratthall and M. Jørgensen:
Can you Trust a Single Data-source Exploratory Software Engineering Case Study
EASE 2001, Keele, England, April

L. Bratthall, E. Arisholm and M. Jørgensen:
Program Understanding Behaviour During Estimation of Enhancement on Small Java Programs
3rd International Conference on Product Focused Software Process Improvement (PROFES 2001). Kaiserslautern, Germany, September 2001.

X. Cai and H.P. Langtangen:
How modern programming techniques can greatly simplify the development of parallel simulation codes in computational mechanics
Proceedings of the MekIT'01 Conference

X. Cai and Å. Ødegård:
On the Performance of PC Clusters in Solving Partial Differential Equations
Proceedings of the Tenth SIAM Conference on Parallel Processing for Scientific Computing

W. Chen and M. Tanaka:
Solution of some inverse heat conduction problems by the dynamic programming filter and BEM
International Symposium on Inverse Problems in Engineering Mechanics 2001, 23-28, Feb. 2001, Nagano, Japan

W. Chen and M. Tanaka:
New RBF collocation schemes and their applications
Int. Workshop Meshfree Methods for Partial Differential Equations

W. Chen:
RBF-based meshless boundary knot method and boundary particle method
Proc. of China Congress on Computational Mechanics 2001, China

W. Chen:
Boundary knot method for Laplace and biharmonic problems
The 14th Nordic Workshop on Computational Mechanics, Sweden.

T. Cicic, S. Gjessing and Ø. Kure:
Performance Evaluation of PIM-SM Recovery
Proceedings IEEE International Conference on Networking, ICN´01, Colmar, France, July 2001

T. Cicic, S. Gjessing and Ø. Kure:
An Improved PIM-SM Tree Recovery Algorithm
Proceedings IEEE Workshop in High Performance Switching and Routing, Dallas, Texas, June, 2001

M. Dæhlen, M. Fimland and Ø. Hjelle:
A Triangle-based Carrier for Geographical Data
Spatial Information and the Environment, Peter Halls (ed.), Taylor and Francis Books Ltd, 2001, 105-120.

M. Dæhlen, M. Fimland and Ø. Hjelle:
A Triangle-based Carrier for Geographical Data, Spatial Information and the Environment
Peter Halls (ed.), Taylor and Francis Books Ltd, 105-120, 2001.

V.S. Wold Eide, F. Eliassen and O. Lysne:
Supporting Distributed Processing of Time-based Media Streams
Proceedings of Distributed Objects and Applications (DOA'01), IEEE, Rome, Italy, Sep 2001, pp. 281-288

A. Fongen, F. Eliassen, I. Ferguson, S. Stobart and J. Tait:
Distributed Resource Recovery Using a Context-Sensitive Infrastructure
Proceedings of Third International Conference on Information Integration and Web-based Applications & Services (iiWAS2001), Vienna, Austria, Sept 2001

O.C. Granmo, F. Eliassen and O. Lysne:
Dynamic Object-oriented Bayesian Networks for Flexible Resource-Aware Content-based Indexing of Media Streams
12th Scandinavian Conference on Image Analysis (SCIA2001), Bergen, June 2001

L. Holden, B.F. Nielsen and A. Almendral:
Stochastic structural modeling in Havana
To be published in the proceedings of the 2001 EAGE conference in Amsterdam, The Netherlands

E. Johansson, L. Bratthall, M. Høst and Anders Wesslen:
The Importance of Quality Requirements in Software Platform Development - a Survey
HICS-34, Hawaii International Conference on System Science, 3-6 Jan 2001, Maui.

M. Jørgensen and D. Sjøberg:
Anchoring Effects: An Important Cause of Too Optimistic Effort Estimates in Software Development Projects
24nd IRIS Conference (Information Systems Research Seminar In Scandinavia), Ulvik, Norway, 11-14 August 2001.

M. Jørgensen, U. Indahl and D. Sjøberg:
Software Effort Estimation by Analogy and Regression Toward the Mean
The Thirteenth International Conference on Software Engineering & Knowledge Engineering (SEKE01), June 13-15, 2001, Buenos Aires, Argentina.

A. Karahasanovic and D. Sjøberg:
Visualizing Impacts of Database Schema Changes - A Controlled Experiment
In 2001 IEEE Symposium on Visual/Multimedia Approaches to Programming and Software Engineering, Stresa, Italy, September 5-7, 2001, pp 358-365, IEEE Computer Society

A. Karahasanovic, D. Sjøberg and M. Jørgensen:
Data Collection in Software Engineering Experiments
In Managing Information Technology in a Global Economy, 2001 Information Resources Management Association International Conference IRMA 2001, Software Engineering Track, Toronto, Ontario Canada, May 2

E. Koren:
Information collection and investigation for software process improvement - a case study
Generative and Component Based Software Engineering (GCSE) Young Researcher Workshop, Erfurt, Germany, September 2001

H.P. Langtangen and X. Cai:
A Software Framework for Easy Parallelization of PDE Solvers
Parallel Computational Fluid Dynamics 2000

H.P. Langtangen and G. Pedersen:
Propagation of Large Destructive Waves
In H..I. Andersson and B. Skallerud, editors, Computational Mechanics (MekIT'01)

A.C. Lien and E. Arisholm:
Evolutionary Development of Web-applications - Lessons learned
European Software Process Improvement Conference (EuroSPI'2001), Limerick Institute of Technology, Ireland, November 2001

O. Lysne and T. Skeie:
Load Balancing of Irregular System Area Networks through Multiple Roots
In Proceedings of 2nd International Conference on Communications in Computing (CIC'2001), pages 165-171, 2001.

M. Manzke, S. Kenny, B. Coghlan, and O. Lysne:
Tuning and Verification of Simulation Models for High Speed Interconnect Fabrics.
Proceedings of PDPTA 2001, Las Vegas (USA).

K.-A. Mardal and H.P. Langtangen:
An efficient parallel iterative approach to a fully implicit mixed finite element formulation for the Navier-Stokes equations
ECCOMAS CFD 2001, Computational Fluid Dynamics Conference Proceedings

T. Olsson, N. Bauer, P. Runeson and L. Bratthall:
An Experiment on Lead-Time Impact in Testing of Distributed Real-Time Systems
METRICS 2001, 4 - 6 April, London, England.

H.O. Rafaelsen and F. Eliassen:
Towards support for ad-hoc mulitmedia bindings
Proceedings of Multimedia Middleware (M3W'01), ACM, Ottawa, Canada, Oct 2001, pp. 36-39

H.O. Rafaelsen and F. Eliassen:
Trading Media Gateways with CORBA Trader
Proceedings of Distributed Objects and Applications (DOA'01), IEEE, Rome, Italy, Sep 2001, pp. 115-124

S.A. Reinemo, O. Lysne, T. Skeie, B. Dobinson, S. Haas, and B. Martin:
Topologies and Routing in Gigabit Switching Fabrics
In Proceedings of 2nd International Conference on Communications in Computing (CIC'2001), pages 142-149, 2001.

T. Sevaldrud and R. Aasgaard:
Distributed handling of level of detail surfaces with binary triangle trees
In Proceedings of ScanGIS 2001, pp. 45-58

D. Sjøberg, E. Arisholm and M. Jørgensen:
Conducting Experiments on Software Evolution
International Workshop on Principles of Software Evolution (IWPSE 2001) September 10-11, 2001 Vienna, Austria

T. Skeie, S. Johannessen, and Ø. Holmeide:
Highly Accurate Time Synchronization over Switched Ethernet
In proceedings of 8th IEEE conference on Emerging Technologies and Factory Automation (ETFA'01), pages 195-204, 2001.

Books – PhD theses

E. Arisholm:
Empirical Assessment of Changeability in Object-Oriented Software
PhD Thesis, ISSN 1501-7710, No. 143, Unipub forlag, Oslo, February 2001.

L. Bratthall:
Empirical Studies of the Impact of Architectural Understanding of Software Evolution
PhD Thesis, ISSN 1501-7710, No. 141, Unipub forlag, Oslo, March 2001.

G.N.C Kirby, A.Dearle and Dag Sjøberg:
Persistent Object Systems
9th International Workshop, POS-9, Lillehammer, Norway, September 6-8, 2000, Revised Papers. LNCS 2135, Springer-Verlag 2001.

H. Moe:
Effect of topography on flows, tides and vortices
Dr. Scient Thesis, Department of Mathematics, University of Oslo

J.E. Hannay:
Abstraction Barriers and Refinement in the Polymorphic Lambda Calculus

Other scientific publications (incl. Research reports and preprints)

F. B. Benth, L. Ekland, R. Hauge, Bjørn Fredrik Nielsen:
On arbitrage-free pricing of forward contracts in energy markets
Preprint No. 14 at The Dept. of Math., University of Oslo

A. Bounaim:
On the solution of an unsteady optimal control problem using domain decomposition techniques
Preprint to besubmitted

W. Chen:
Several new domain-type and boundary-type numerical discretization schemes with radial basis function
preprint

W. Chen:
Errata and supplements to: Orthonormal RBF Wavelet and Ridgelet-like Series and Transforms for High-Dimensional Problems
preprint

W. Chen and Y.C. Hon:
Numerical convergence of boundary knot method in the analysis of Helmholtz, modified Helmholtz, and convection-diffusion problems
Preprint

T. Cicic, S. Gjessing and Ø. Kure:
Topology Construction for Inter-Domain Network Protocol Simulations
Research Report No. 296, Department of Informatics, University Of Oslo, ISBN 82-7368-246-3.

T. Cicic, S. Gjessing and Ø. Kure:
Evaluation of the Inter-Domain Multicast Protocols MSDP and BGMP
Submitted

M. Jørgensen and D. Sjøberg:
Software Effort Estimation by Analogy and Regression Toward the Mean?
To appear in Journal of Software Engineering and Knowledge Engineering (SEKE).

G. Lines, X. Cai and A. Tveito:
A parallel solution of the bidomain equations modeling the electrical activity of the heart Submitted for publication

T.K. Nilssen and X.-C. Tai:
Parameter estimation with the augmented Lagrangian method for a parabolic equation
Report-153, Department of Mathematics, University of Bergen

T.K. Nilssen, T. Mannseth and X.-C. Tai:
Permeability estimation with the augmented Lagrangian method for a nonlinear diffusion equation
Report-155, Department of Mathematics, University of Bergen

T. Skeie, S. Johannessen, and C. Brunner:
Ethernet in Substation Automation
IEEE Control Systems Magazine, to appear June 2002.

Other Publications

M. Dæhlen, Simula Research Laboratory:
- Early days!
Simula report, 2001.

R.H. Gabrielsen and M. Dæhlen:
Utnytt potensialet i norsk forskning
Chronicle in the Norwegian newspaper Bergens Tidende, 2001.

M. Dæhlen:
NRK må forske mer
Chronicle in the Norwegian newspaper Dagens Næringsliv, 2001

Doctors and cand. scient-degrees in 2001

Doctor	**Counselor**	**Thesis**
Erik Arisholm	Dag Sjøberg	Empirical Assessment of Changeability in Object-Oriented Software
Lars Bratthall	Magne Jørgensen Dag Sjøberg	Empirical Studies of the Impact of Architectural Understanding of Software Evolution
J.E. Hannay	Donald Sannella Martin Hoffmann	Abstraction Barriers and Refinement in the Polymorphic Lambda Calculus
H. Moe	Bjørn Gjevik	Effect of topography on flows, tides and vortices

Cand.scient.	**Counselor**	**Thesis**
Gunnar Bergersen	Dag Sjøberg, Knut Nordby	User Interface in 3D multi-user environment
Rasmus Bording	Hans Petter Langtangen	Renderman high quality visualisation
Camilla Brekke	Magne Jørgensen, Dag Sjøberg	Roster planning: User interface and support tool evaluation
Thomas M. Dørum	Frank Eliassen	Trading of explicit binding
Helle Frøyseth	Dag Sjøberg, Geir Hasle	Roster planning and algorithms
Bente Aa. Fykerud	Magne Jørgensen, Dag Sjøberg	Structure of menus in roster planning
Roger Hansen	Hans Petter Langtangen	Scripting in High-Performance Computing
Rolf-Arne Haugen	Dag Sjøberg, Aslak Tveito	Architecture and components in roster planning systems
Svein P. Larsen	Stein Gjessing, Sverre Haug	QoS-architectures in the Internet
Merete D. Lohne	Aslak Tveito, Glenn Lines	Stability and perturbation analysis of some select mathematical heart models
Roger W. Olsen	Ole-Christoffer Granmo	Component framework for Distributed Media Journalling
Umair Rasool	Dag Sjøberg, Amela Karahasonovic	Schema Evolution in the Oracle8i Database Management System
Kirsten Ribu	Bente Anda, Dag Sjøberg	Estimating object-oriented software projects with use cases
Haakon F. Spilde	Magne Jørgensen, Eigil T.Skorve	System integration using an object-oriented framework - an evaluation of J2EE Connector Architecture
Gunnar K. Wold	Magne Jørgensen, Eigil T. Skorve	System integration using an object-oriented framework - an evaluation of J2EE Connector Architecture

The owners of Simula

Simula research Laboratory is a limited company with the following owners:

University of Oslo (UiO)
Norwegian University of Science and Technology (NTNU)
University of Bergen (UiB)
University of Tromsø (UiTø)
Norwegian Computing Center (NR)
Sintef

The operation of the Simula centre 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, who will also run the evaluation of the centre, with support from international experts.

The Board of Directors in 2001

Professor Jan Trulsen: Leader, representing UiO
PhD Student Bente Anda: Employed at Simula
Vice president, Research Tore Gimse: Representing Sintef
Professor Odd Gropen: Representing UiTø
Rector Eivind Hiis Hauge: Representing NTNU
Research director Kristen Haugland: Representing UiB
Managing director Lars Holden: Representing NR
PhD Student Linda Ingebrigtsen: Employed at Simula
Harald Holm Simonsen, observer The Research Council of Norway

Scientific Advisory Board

Professor Malcolm P. Atkinson: University of Glasgow, UK
Professor David Hutchison: Lancaster University, UK
Professor Rolf Jeltsch: ETH Zürich, Switzerland
Professor Dieter Rombach: University of Kaiserslautern, Germany

Employed at Simula Research Laboratory

Administration
Morten Dæhlen: Professor, Managing Director
Jarle Nygard: Assisting Director
Wenche Angel: Executive Officer, Economy
Ragnfrid Sjøberg, Executive Officer
Bjarne Røsjø: Information Consultant

The Communication Technology Department
Frank Eliassen: Professor, Research Director
Viktor S. Wold Eide: PhD Student
Stein Gjessing: Professor
Ole Christoffer Granmo: PhD Student
Øyvind Hanssen: Scientific Programmer
Geir Horn: PhD Student
Olav Lysne: Professor
Sven-Arne Reinemo: PhD Student
Tor Skeie: Dr., Research Scientist
Richard Staehli: Dr., Research Scientist
Ingebjørg Theiss: PhD Student
Minh Van Tran: PhD Student

The Scientific Computing Department
Aslak Tveito: Professor, Research Director
Xing Cai: Assoc. Professor
Wen Chen: Dr., Research Scientist
Monica Hanslien: Research Assistant
Øyvind Hjelle: Visiting Research Scientist
Helge Holden: Visiting Professor
Sverre Holm: Visiting Professor
Linda Ingebrigtsen: PhD Student
Kenneth Karlsen: Visiting Assoc. Professor
Hans Petter Langtangen: Professor
Knut-Andreas Lie: Visiting Research Scientist
Glenn Lines: Dr., Research Scientist
Kent-Andre Mardal: PhD Student
Halvard Moe: Dr., Scientific Programmer
Bjørn Fredrik Nielsen: Assoc. Professor
Trygve K. Nilssen: Post.doc.
Thomas Sevaldrud: Scientific Programmer
Ola Skavhaug: PhD Student
Joakim Sundnes: PhD Student
Tom Thorvaldsen: PhD Student
Yota Tsompanopoulou: Post.doc.
Åsmund Ødegård: Scientific Programmer

The Software Engineering Department
Dag Sjøberg: Professor, Research Director
Bente Anda: PhD Student
Erik Arisholm: Assoc. Professor
Lionel Briand: Visiting Professor
Gunnar J. Carelius: Senior Engineer
Reidar Conradi: Visiting Professor
Tore Dybå: Visiting Research Scientist
Glen Farley: Advisor
Hans Gallis: PhD student
Jo Hannay: Post.doc.
Letizia Jaccheri: Visiting Assoc. Professor
Magne Jørgensen: Assoc. Professor
Amela Karahasanovic: PhD Student
Espen Koren: PhD Student
Kristen Nygaard: Visiting Professor Emeritus
Kirsten Ribu: Research Assistant
Marek Vokác: PhD Student

[**simula** . research laboratory]

Simula Research Laboratory is a research centre conducting basic long-term research on select areas within information and communication technology. Through its operation the centre is supposed to contribute to innovation in Norwegian industry.

Visiting address:
Martin Linges v 17, Fornebu
Postal address:
P.O. Box 134,
NO-1325 Lysaker, NORWAY

Phone : +47 67 82 82 00
Fax : +47 67 82 82 01

www.simula.no