ERCIM NEWS

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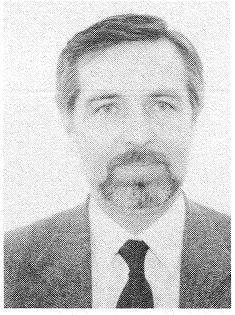

Stelios Orphanoudakis
Acting Director of ICS – FORTH
(Photo: FORTH)

SPECIAL :

Activities in Software Quality
Principles and Techniques

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Next Issue:

Numerical Linear Algebra

EDITORIAL

The main theme of this issue is Software Quality and related activities in ERCIM. Rather than discussing Software Quality, this editorial will consider issues related to Research Quality, a topic which ought to have broader implications for ERCIM and the European research community in general. Research Quality, much like Software Quality, is not always easy to put your hands on and yet we all have an intuitive notion of what it is; in the academic world, we sometimes even try to characterise it in quantitative terms. However, giving a precise definition of what constitutes quality in research or establishing means to quantify it may not be all that important. Perhaps more important is for the academic and research community to work toward creating an environment which promotes research quality and innovation at a National and European level.

FORTH has recently joined ERCIM with the expectation that the above goal will be pursued and eventually achieved through closer cooperation among ERCIM members, as well as between ERCIM and the European Communities, the European research community at large, and industry. The key to productive cooperation in all cases is communication. Thus, ERCIM should establish direct channels of communication with sufficient capacity, at different levels and across national and institutional boundaries. All types of cooperation mentioned above are important in creating the right environment for quality research and innovation. Communication and cooperation with European industry is particularly important, if the outcome of research effort is to be focussed and addressing real needs timely, thus strengthening its competitiveness.

ERCIM, combining the strengths of its member institutions, is in a favourable position to act as a catalyst for developments which will raise the level of European research, particularly in the areas of information technology and applied mathematics. To precipitate such developments, ERCIM needs to define goals and strategies, which will influence and even determine scientific policy.

Whereas the goal of creating an environment which promotes research quality and innovation in a European context is a scientific goal most of us can agree upon, the process of arriving at a consensus on some policy or strategic issues may be at times challenging, stimulating very interesting discussions, but the results are bound to be rewarding. However, agreement on scientific goals and strategies ought to be easier to obtain and may form the basis for reaching a consensus on other issues.

Stelios Orphanoudakis

SINTEF DELAB joins as ERCIM's Norwegian Partner

by Truls Gjestland

SINTEF DELAB formally became a member of ERCIM, along with FORTH, at the last ERCIM meeting held in Pisa in May, increasing the number of partners in the consortium to eight.

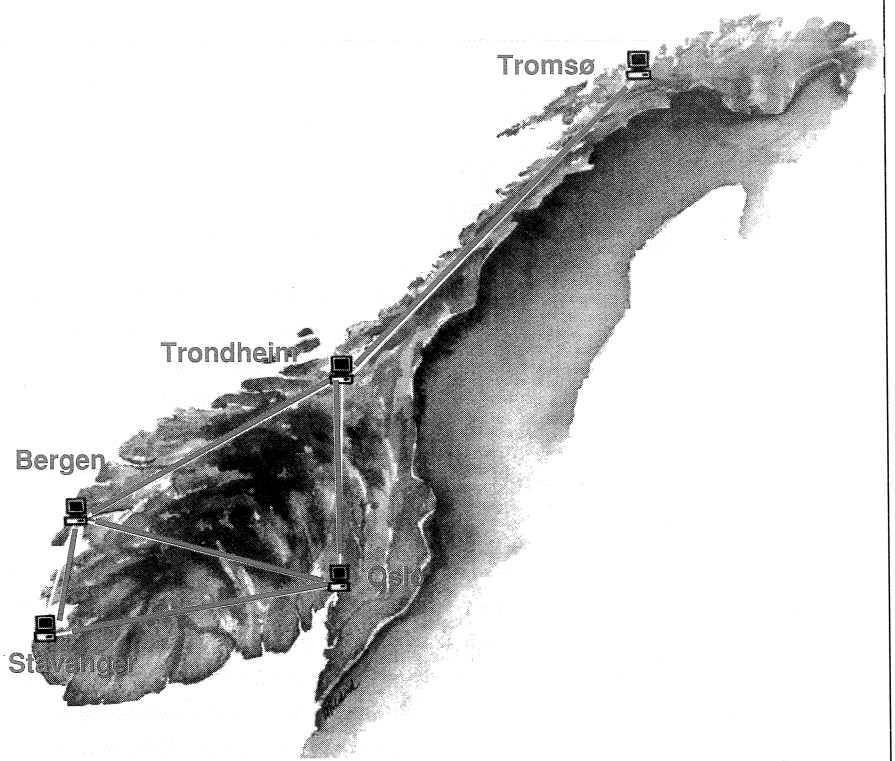
The SINTEF Group in Trondheim, Norway, is the largest independent research organisation in Scandinavia. Our staff of two thousand complete about 3000 projects each year for clients all over the world. Our research spans most technological disciplines, the natural and social sciences, and medicine.

The SINTEF Group cooperates closely with the Norwegian Institute of Technology (NTH). This enables the institutions to share laboratories, equipment and specialist staff; a significant contribution to expertise. In size and quality, the SINTEF/NTH research community has an established international position as a leading technological innovator.

Our business idea is to provide research and development services to public and private industry, agencies and administrations. We have a growing number of international clients.

Depending on the type of project we can offer highly skilled professionals to solve a problem, offer additional capacity to the client's own research department, give access to special laboratory facilities, provide software and computing capacity, etc.

Project teams can be established together with the client, and the work can be done either in-house or at the client's premises. Implementation of the results of a development project is often done by our staff working in close contact with the client's own manufacturing department.



SINTEF DELAB plays a key role in the operation of UNINET, a computer network that links universities and research organisations in Norway.

SINTEF DELAB, specialising in information technology, is a dominating division in the SINTEF Group. We have a staff of about 175 and a turnover around 112 million NOK (14 million ECU). More than 130 members of staff hold masters or doctoral degrees from leading universities, and together with the personnel at the associated department at NTH, we total more than 300, making this the largest information technology centre in Scandinavia.

Our main research areas can be categorised as follows:

- Knowledge Based Systems including knowledge acquisition, modelling and engineering, expert systems, image processing and user interfaces.
- Database Technology including distributed databases, transaction oriented information systems, data models, database extendibility and database environments.
- Software Engineering Technology including methods and tools for system development and reuse, transformation technologies, purpose directed development of real-time systems, quality assurance, quality and productivity metrics and safety and reliability analysis.
- Communication Networks including distributed heterogeneous networking, network systems, administration and switching, distributed applications, traffic models, security systems and switching system reliability.
- Radio Communication including satellite systems, sensor systems, antennas, microwave engineering and circuit design.
- Transmission Systems including mobile communications, coding, modulation and information theory.

- Acoustics including speech processing, room acoustics, transportation noise, noise abatement and underwater acoustics.
- High Speed Electronics including design, modelling, prototyping, characterisation and testing of integrated circuits, modules and interconnects.
- Thin Film Technology including submicron laboratory facilities with molecular beam epitaxy for electronic and electro-optic devices.
- Optical Communications including optical fibres, switches, lasers and coherent detection techniques.
- Surface and Bulk Acoustic Waves for analog signal processing.
- VLSI design including design for testability, built-in self test, boundary scan techniques and design quality modelling.
- Measurement Equipment and Sensor Technology including optical, electronic and acoustical sensors and instrumentation systems.

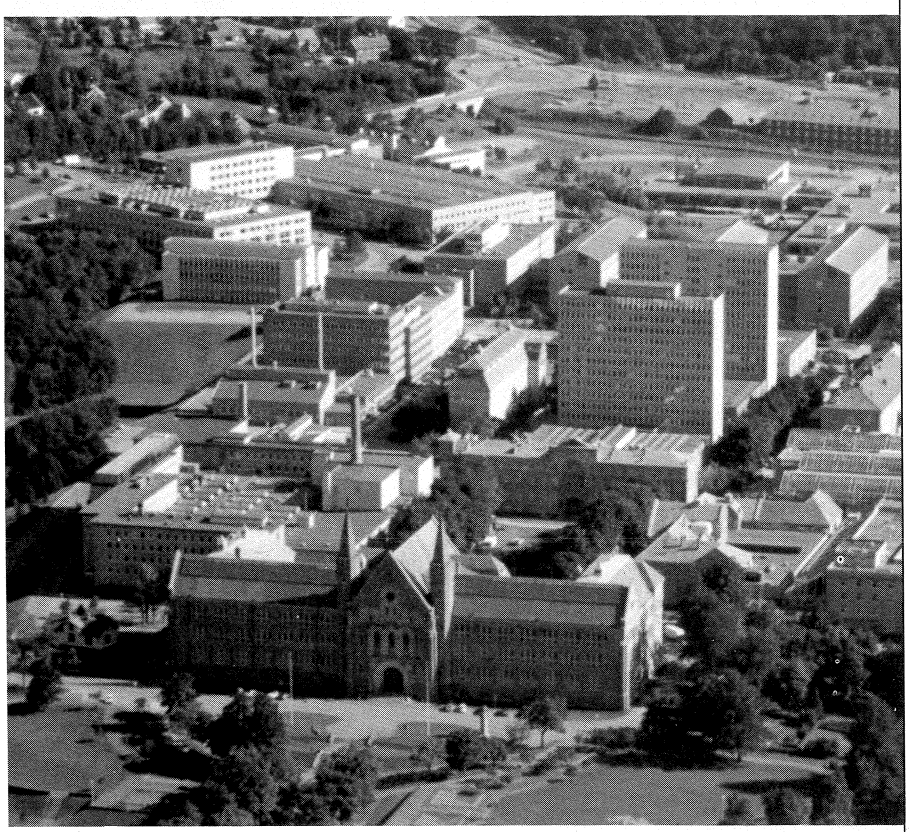
SINTEF DELAB, or just DELAB among friends, participates in several European research programs: GAUDI and ADEPT under the DRIVE program, PROTEUS, CAFE and UNITE under the ESPRIT program and CTA under the EUREKA program. Our previous record include among other projects participation in SAM, PARASOL, REBOOT, RARE, MHS and ACKNOWLEDGE.

DELAB plays a key role in the operation of UNINETT, a computer network for Norwegian universities and research organisations. We also participate in the COSINE program and the Internet x.400 project. In Norway we are a centre of excellence for x.400 electronic mail systems.

The Norwegian Telecom Research is one of our major clients. Together we contributed significantly to the standardisation of the new pan-European mobile telephone system, GSM. The new system is to a large extent based on the results of a joint study project carried out at DELAB.

DELAB has participated in a number of projects within the field of satellite communication. INMARSAT and INTELSAT are among our customers, and we have a long lasting cooperation with ESA, the European Space Agency. One of their last satellites, ERS-1, carries an altimeter in the payload with SAW-components developed by DELAB.

Two other SINTEF divisions may also be of particular interest to the ERCIM News reader: SINTEF Industrial Mathematics and SINTEF Automatic Control. Our division for Industrial Mathematics specialises in mathematical modelling and large scale supercomputing. Their computing facilities include a CRAY Y-MP D4/464 Supercomputer.



This is a 4 processor 512 Mbyte computer with a capacity of 1.3 GFlops. It operates in a UNIX environment, but can also be accessed from other non-UNIX hosts.

Our division for Automatic Control specialises in general process control systems, mathematical modelling and simulation, instrumentation, and man-machine interface and decision support systems.

Technically and legally SINTEF is a foundation. This implies that all of the profit remains in SINTEF, and there are no outside parties that draw funds out of the foundation. On the other hand, there are no outside financing sources, either, so all our income is generated by "sale" of know-how through research and development projects. ■

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The Norwegian Institute of Technology and SINTEF are located at the same campus in Trondheim.

ERCIM Meeting at CNR

by Giorgio Faconti

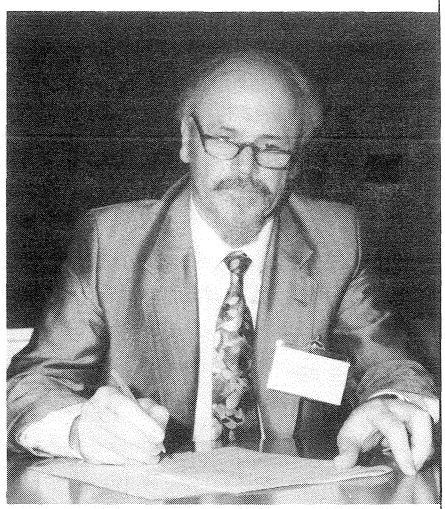
The ERCIM Workshops are organised in order to permit researchers in the partner Institutes to exchange ideas and experiences, and also to introduce new partners as they enter the Consortium. The most recent in the series was hosted by the CNR Informatics Institutes in Pisa, 21-22 May 1992. Approximately 130 researchers from the different ERCIM members participated in the meeting; representatives from universities and industries sharing common research activities with ERCIM members were also present.

There were three separate workshops on the following themes:

- Numerical Linear Algebra
- Software Quality Principles and Techniques
- Theoretical and Experimental Aspects of Knowledge Representation

A one-day Steering Committee Meeting was organised previous to the Workshops in order to discuss ERCIM policy in preparation for the Directors' Meeting, which was held during the Workshops. The Steering Committee also selected the next 6 ERCIM Fellows from the large number of candidates who had first been evaluated by the separate member institutions. The Directors' Meeting was of particular importance as, among other things, much time and discussion was given to the future strategy of ERCIM and the role which should be played by ERCIM in the scientific community.

At the plenary session on the final day, two new Institutes formally signed the agreement making them official ERCIM partners: The Institute of Computer Science of FORTH - the Foundation of Research and Technology – Hellas (see ERCIM News No.9) and SINTEF DELAB (see page 2), bringing the current number of ERCIM partners up to eight.



Two new institutes formally join ERCIM : The Directors of FORTH and SINTEF DELAB seen here signing the agreement at the plenary session on the final day of the ERCIM meeting in Pisa. From left to right: Aage Thunem, Director of SINTEF DELAB (Norway) and Eleftherios Economou, President of FORTH (Greece). (Photos: IEI-CNR)

Brief reports by the coordinators of the three workshops appear below.

Software Quality Principles and Techniques

Fourteen papers were selected by the local organisers at each ERCIM site, in order to obtain a representative picture of activities in the SQ field throughout the ERCIM community. The contributions ranged over topics such as: Models, Metrics, Techniques, Formal Methods.

The quality of the papers and the presentations was rated as high by most of the participants. As there were many interventions from the floor, it was not easy to keep the presentation time within the prefixed schedule.

In particular, the session on Metrics stimulated a lively comparison of the different definitions and opinions formulated. The necessity of introducing Formal Methods for Quality also encountered contrasting positions.

The very definition of Software Quality was debated in the concluding panel session by a speaker from each ERCIM site. This encouraged further general discussion which included the audience, and resulted in the following proposals:

- the setting up of a European "Distributed Software Engineering Laboratory";
- an e-mail bulletin to disseminate information on the activities carried out in this area at the different sites;
- periodic meetings on SQ in general or on more specific topics.

The workshop closed with a general commitment to keep interest alive by frequent e-mail contacts. ■

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Theoretical and Experimental Aspects of Knowledge Representation

The first ERCIM workshop on KR met with considerable interest from the ERCIM community working both in the theoretical and in the experimental sides of knowledge representation; this was evidenced by the high number of submissions and participants. The papers presented led to a number of lively discussions. Although the contributions addressed practically all fields of KR, three trends clearly emerged.

One trend that is consistently represented within ERCIM is the study of terminological logics. These logics are the descendants of the frame-based knowledge representation languages of the late 70's. ERCIM researchers have used the recent results on the computational complexity of these logics as a basis on which to investigate their extension by means of non-monotonic features, the strengthening of their expressive power and their application to clarifying the semantics of object-oriented data models. A second direction that was particularly noticeable during the Workshop was a new impulse towards the study of formalisms for the representation of temporal knowledge, partly caused by the recent resurgence of interest in planning in the artificial intelligence community. A third, particularly important, trend that emerged from the workshop is the heavy investment that the research community is putting into the semantic analysis of natural language. This is epitomised by Dynamic Predicate Logic, a major area of investigation within ERCIM that seems to have a considerable potential not only in terms of natural language processing applications, but also as a unifying paradigm for the study of knowledge and information. ■

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The ERCIM Workshops, hosted by CNR Informatics Institutes in Pisa on 21–22 May 1992, brought together approximately 130 researchers from the different ERCIM institutes. (Photo: IEI-CNR)

Numerical Linear Algebra

Twelve contributions were submitted to the Numerical Linear Algebra Workshop from four of the member organisations: INRIA, RAL, CWI and CNR

The quality of the papers was high, partly because of the decision made by the coordinators not to make an open call for papers; contributions were requested directly from the Local Coordinators who made a selection. The subjects covered almost all the main areas of numerical linear algebra, both in sequential and parallel; the most recurring themes were iterative methods for solving large and sparse (and structured) linear systems, and the computation of the eigenvalues of matrices.

The topics covered almost all the main areas of numerical linear algebra, both in sequential and parallel computation environments. The most recurring theme was that of iterative methods (in particular the conjugate gradient method and its variants) for solving large and sparse (and structured) linear systems. The issue of ill-conditioned systems was also considered, and preconditioning techniques were proposed. The case of systems defined over finite fields was taken into consideration by one contribution. The other major theme addressed was the computation of eigenvalues for both symmetric and unsymmetric matrices. Finally, a few papers dealt with selected special topics, such as the error analysis of methods for computing the matrix exponential, and strategies for achieving a high load balancing in parallel Gaussian elimination algorithms.

The success of the workshop confirms the need to consolidate and extend the role actually played by mathematics (both theoretical and applied) in ERCIM. ■

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ERCIM Advanced Course

Partial Differential Equations and Group Theory: New Perspectives in Computer Algebra and Group Theory

by Jean-François Pommaret

In line with a previous course held at INRIA in November 1990, the ERCIM Advanced Course "Partial Differential Equations and Group Theory", held at GMD from 6–10 April 1992, was quite successful with 45 participants coming from 15 countries including the USA, Canada, Australia, South Africa, Venezuela and most of western Europe. Accordingly, it will be repeated next year at CWI, Amsterdam, from 22–26 March 1993, with the support of INRIA, GMD and CAN.

As a basic motivation for organising such a course, one must notice that the widespreading importance of computer algebra today hides the fact that most of the algorithms concerning PDE only use mathematics that were in fashion 50 years ago. Indeed, the formal theory of PDE and groups of transformations has been created and developed during the years 1960 to 1975 by Donald Spencer in the USA. However, though this work supersedes the classical approaches (Maurice Janet, Elie Cartan), it is still largely unknown by mathematicians and has never been applied. Also, it is a fact that, during the last 10 years, people have been trying to study nonlinear phenomena by means of formal algebraic or geometric techniques instead of numerical or functional ones.

Therefore, the purpose of the course is to give a self-contained introduction, at a graduate level, to these new tools, while illustrating them with specific examples coming from various branches of engineering sciences and applied mathematics. In particular, the course presents for the first time the long-awaited group theoretical unification of the mathematical models of elasticity, heat and electromagnetism, allowing for a unique finite elements formulation.

■

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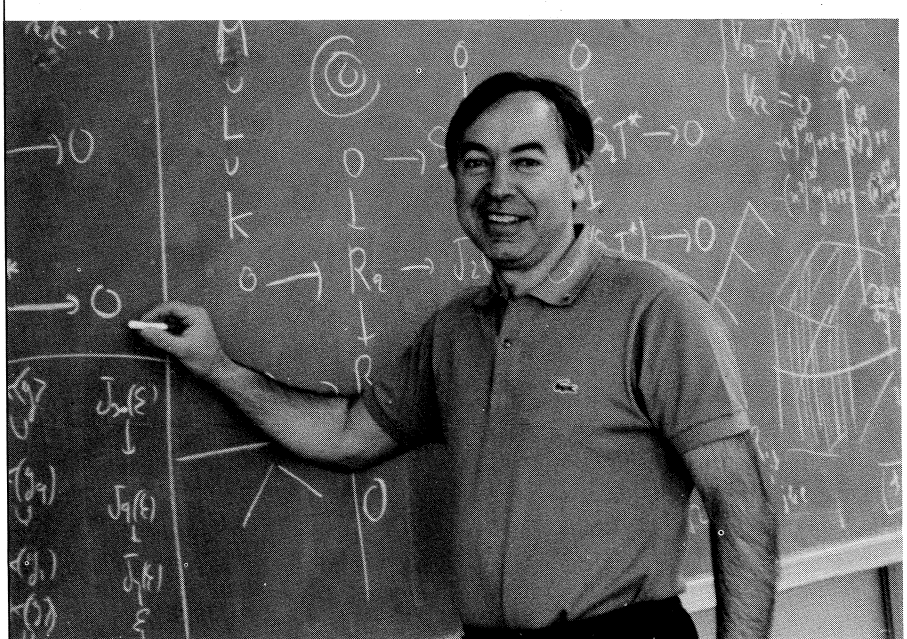

The main speaker, Jean-François Pommaret, in action!
(Photo: Münch, GMD)

ERCIM Workshop

Theory and Practice in Verification

by Stefania Gnesi

The workshop is intended to provide a bridge between theory and practice in formal verification of concurrent and distributed systems, such as protocols, real-time control systems and digital systems. The workshop aims at providing ERCIM researchers with an opportunity to share theoretical results and practical experiences in the field of formal verification.

Typical but non exclusive subjects include:
- Verification Theories;
- Formal Verification Methods and Tools;
- Issues in Automatic Verification.

Particular attention will be given to verification techniques for non finite-state systems, case studies and attempts at integrating different verification techniques and tools.

The workshop will be held in Pisa, 9-11 December 1992, and is organised by Alessandro Fantechi, Stefania Gnesi, Paola Inverardi (IEI-CNR), and Diego Latella (CNUCE-CNR). The number of participants will be limited to 40 persons. Papers are solicited from ERCIM sites by October 1st 1992. Each site can also invite external collaborators. Participation will be considered according to the appropriateness to the workshop theme.

Papers (max.10 pages) should be sent, or a TeX version e-mailed to:
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Next ERCIM Meeting

The next ERCIM Meeting will be held on 29-30 October this year, hosted by The Institute of Computer Science of FORTH in Heraklion, Crete, Greece. Four workshops will be organised, described briefly below.

1. Parallel Architectures for Computer Vision

The efficient implementation of integrated vision tasks on parallel architectures constitutes a challenging problem, which requires careful consideration of the computational and communication requirements of such tasks, the resources provided by different parallel architectures, and the dependence of load distribution at different levels of vision on image content. Intermediate level vision tasks are of particular interest in this context due to the substantial data reduction which occurs at this level of computer vision, the resulting load balancing requirements, and the variety of data structures used to represent intermediate results at each processing step.

Papers are invited on all methodological and practical issues related to the efficient implementation of integrated vision tasks on parallel architectures. All researchers currently involved in related work on parallel image analysis and load balancing algorithms, integrated vision systems/architectures, and applications are encouraged to submit papers. It is intended that this workshop will serve as a forum for the exchange of ideas and specific experiences in this important area of active research.

Coordinator:
Stelios Orphanoudakis, FORTH-ICS
email: orphanou@csi.forth.gr

2. Network Management

This workshop is dedicated to bringing together researchers in the area of management for high-speed networks, and to discuss and compare the existing state-of-the-art technology of network management tools. There will be a balance between theoretical and experimental work to be presented. We expect each participating organisation to present its current network management solution and to discuss its future plans. The possibility of creating an integrated high-speed network connecting all the organisations with a common network management platform will be discussed. Emphasis will be placed on the following topics:

- ATM network management (quality-of-service, call acceptance, performance and fault management, etc.).
- Experience with existing state-of-the-art network management tools.
- Use of expert systems in network management.
- Integrated network management.
- Network management for applications of high-speed networks with special requirements (multimedia applications, pacs-to-pacs interconnections, video, etc.).
- Security of computer networks.
- Future trends in network management.

Coordinator:
Costas Courcoubetis, FORTH-ICS
email: courcou@csi.forth.gr

3. Methods and Tools for Software Reuse

This workshop is intended to address the scientific, technical and pragmatic issues involved in achieving software reuse while developing software systems.

Topics include, but are not limited to:

- Designing-for-reuse and designing-with-reuse methods.
- Development methodologies promoting (and taking advantage of) reuse.
- Selection and adaptation of software artifacts.
- CASE environments and support tools for reuse.
- Reusing designs, requirements, specifications, experiences, development histories and code; software repositories.
- Programming languages and reuse.
- Innovative factors for reuse.

As usual, both research papers on theoretical and experimental aspects of software reuse and state-of-the-research papers carried out in ERCIM sites are sought. The Workshop will consist of selected presentations and will conclude with a panel summarising the major results.

Coordinators:
Panos. Constantopoulos, FORTH-ICS
email: panos@csi.forth.gr
and: Yannis Vassiliou, FORTH-ICS
email: yannis@csi.forth.gr

4. Numerical Methods for Linear and Nonlinear Problems in Wave Propagation

The workshop on Numerical Methods for Linear and Nonlinear Problems in Wave Propagation will be coordinated by Vassilios Dougalis and John Papadakis of the Institute of Applied and Computational Mathematics of FORTH. Papers are solicited on all aspects of numerical modelling and analysis of numerical methods for linear wave propagation problems (with emphasis on electromagnetic and elastic waves and underwater acoustics) and for nonlinear problems (with emphasis on non-linear dispersive waves and conservation laws).

Contact person:
Vassilis. Dougalis, FORTH-IACM
email: dougalis@theseas.ntua.gr

Submission instructions

The number of presentations will be limited to approximately 14 per workshop and not more than 4 per ERCIM partner per workshop. Full papers should be submitted in three copies by post (no e-mail submissions). Contributions must be received by 11 September, 1992. Notification of acceptance will be mailed by 25 September, 1992. Camera-ready versions must be received by 16 October.

Please send papers to:
Institute of Computer Science - FORTH
P.O. Box 1385
GR-711 10 Heraklion, Crete, Greece
Attn: <Coordinator-name>
ERCIM Workshops ■

Software Quality Principles and Techniques: Activities within the ERCIM Institutes

by Antonia Bertolino and Mario Fusani

It may well be that the land of Software Quality lies in the realm of Utopia. However, we can be certain that it is a highly receptive and free trading country, importing methodologies from any branch of software technology, and not only. Indeed, it would be very hard to identify a territory of Information Science that is totally foreign to SQ.

That the boundaries of SQ are not yet well established is evident from the fact that no more technical definition than the quite general and ambitious *quality is satisfaction of user's needs* is attempted in the literature. And indeed this is the conclusion that can be drawn from a first glance at the multi-coloured range of reports describing on-going research activities in SQ principles and techniques in this section of ERCIM News. This situation is also confirmed by the contributions to the ERCIM Workshop on the same subject organised by CNR, Pisa, in May (see page 4).

The task of introducing this rich variety of articles as a homogeneous group is extremely challenging as it implies starting to define and build up a general discipline for SQ. Unfortunately, it is also a very tough task. As the readers can judge on their own, and without belittling their individual worth, the contributions come from the most disparate areas, lacking, at the present state of the art, a common organisation and integrated objectives. An example of this multidisciplinariety is readily provided by the long list of SQ relevant topics in which INESC is active (Velga).

Some of the research projects appear to follow more *traditional* SQ tracks, even though each presents its own innovative and attractive aspects. We refer to the Gateway project on metrics at RAL (Behrendt); the Oikos project on software process models at the University of Pisa (Montangero and Ambriola); the Oblog approach to quality assurance and maintenance at INESC (Reichwein, Sernadas and Fiadeiro); the ITHACA project on development environments, whose Software Information Base is being developed at FORTH (Constantopoulos and Doerr).

On the contrary, at least according to traditional frameworks, it is less easy to see how other projects fit within the framework of SQ, as they act directly on very different disciplines and span over a wide range: the study of software reliability models using mathematical statistics at CWI (van Pul); the conceiving of methods for automated programming at GMD (Jähnichen and Burghardt); the development of methodologies for reliable database design at CNR (Castelli and Locuratolo); the construction of reference software for the assessment of geometric measurement systems at CWI (Jan Kok). At the same time, nobody could prove that any of these topics is not related to SQ; in fact, they refer, respectively, to specific attributes of SQ, such as reliability (van Pul) and correctness (Jähnichen and Burghardt) and approaches to SQ control, such as stepwise refinement (Castelli and Locuratolo) and SQ assurance, such as validation (Jan Kok).

The most relevant conclusion we can draw on the section as a whole is that such a flourishing of contributions should certainly stimulate constructive comparison between the different approaches and encourage profitable exchanges of ideas and even cultures, which are surely the main goals of ERCIM itself. ■

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Aspects of Software Quality in ITHACA

by Panos Constantopoulos and Martin Doerr

ITHACA is a large ESPRIT-II project the objective of which is to develop an integrated object-oriented software development environment, thus eventually reducing the costs of producing new applications. It is based on three major principles:

- development of components guided by formal requirement specifications
- detection and creation of generic components and the provision of large evolving libraries of such components.
- reuse and refinement of existing components and other knowledge acquired during previous developments (designs etc.)

The major efforts aim at creating a strictly object-oriented programming language (CooL), with persistent objects held in a database (CooMS), a debugger (MAX), a visual scripting tool (VISTA), a requirements collection and specification tool (RECAST), a software information base (SIB) and demonstrator applications.

FORTH is responsible for the SIB, which is not simply a software repository, but tries to address two non-trivial issues:

- storage of descriptions and knowledge about the life cycle of a software object with minimal user effort and minimal duplication of information in a semantic network.
- retrieval of arbitrary components by semantic descriptions, associations and similarity.

The programming tools (compilers, database schema generators) enter structural information to the SIB automatically, which can be supplemented manually. The SIB is thus the point where all the crucial information to produce quality software and to decide on and improve software quality is centred.

Even without the above environment, object-orientation by itself has a strong impact on quality. The concept of data hiding enforces the identification of independent data structures with minimal interfaces between them (access methods), which can be changed or modified without side effects.

Furthermore, the concept of isA hierarchies and polymorphism (virtual functions in C++) allow for the design according to semantic structures hiding not only interior data but also "special cases". This increases the probability that an extension in functionality to a given program will affect one semantic unit only.

RECAST, which operates with a higher level user interface on top of the SIB, supports the developer in a formal way to derive such semantic software units from requirements and structures in the end-user domain and maintains the correspondence of requirements to these units for their whole life cycle. Hence the quality of semantically organised structures is improved and future developers are guided to preserve the intended semantics during modifications. The probability that the end product actually does what was required is increased, which is another quality aspect.

The general problem of evaluating software quality in contrast to a mechanical device like a car or a computer board is that the main structures are not visible at a first glance. Inline comments describe only unidirectional relations from pieces of code to the items referred.

Hence another major goal of the SIB is to allow a fast and deep insight into software structures by various representation methods currently under development. By simple queries, graphs of transitive structures, such as flowcharts, class hierarchies, data affected by some component, can be produced dynamically with arbitrary criteria. Thus design components with overloaded complexity, or up to now undetected subcomponents can be identified. This helps to improve software structures a posteriori, and also to control possible side effects of an intended modification.
Another aspect is the detection of parallel development of the same or similar functional units, which leads to their combination or unification into generic components, thus reducing the code size considerably. This detection is only possible by capturing the semantics of each component in a formal way, because variable names and inline comments depend on the understanding and habits of the individual programmer.

Making these components available to other programs and developers leads to the general concept of reuse. A major problem is the retrieval of a component to be reused, if its name, precise specifications and existence are unknown. The probability of finding exactly what one is looking for is relatively low, whereas there is a high probability of finding something similar in a large software base, which may be reused by minor modifications either to the initial design or to the retrieved component. Hence the retrieval system must support querying by semantic descriptions and a sound notion of similarity or conceptual closeness.

The impact of reuse, besides the economy of development, is the usage of well tested (trusted) code in terms of stability and using algorithms which turned out to be optimal for the intended use.

In conclusion, the ITHACA approach enforces the following major aspects of software quality :

- robustness of software against modifications and enhancements
- reduction of errors during development and modifications
- usage of well tested, trusted code
- usage of optimal algorithms
- reduction of code needed for a given application.

Partners in the ITHACA project are: Siemens-Nixdorf - Germany (main contractor), Bull - France, Datamont - Italy, TAO - Spain, ICS-FORTH - Greece, University of Geneva - Switzerland. ■

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Quality in Software Systems: Research, Development and Practice

by Pedro Veiga

In the initial phases of software production there is not always motivations for quality. However, when the size of the software increases and\or when the life cycle of the software extends for a long period, maintaining the software can be a very serious and difficult problem, if the software was not built with well established methods.

It is with these problems in mind that, inside INESC, several groups carry out R&D activities in the area of Software Engineering. Some topics of activity that are relevant for software quality are pursued by one more groups inside INESC and are shortly enumerated below:

- The use of formal methods (logical, algebraic and categorial) in the software production cycle, starting from the early phases of specification, and then in the design and the verification, can prove to be crucial in production correct systems.
- The use of well established development methods and their automation by using CASE (Computer Aided Software Engineering) tools can improve the production and the quality of the software production process, by reducing the number of interventions of programmers and by automatically control their activities.
- Development and the use of adequate programming environments (integrated sets of software tools), that can provide the computational support that helps programmers to fully concentrate in the creative aspects of software design and relieve them from the small and error prone activities that contribute to low quality software.
- The usage and promotion of software standards that permit the adoption of techniques to control the software practice and management.
- Another area that is starting to emerge is software metrics. It is felt that this is a rather important area, because the controllability of the software design process mandates the existence of good techniques to measure the success or failure in the use of specific methods and tools (one can only control what can be measured).

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GATEWAY: Metrics for Knowledge Based Systems

by Wernher Behrendt

RAL's Knowledge Engineering Group has been involved in a joint industrial/academic research project developing metrics for knowledge based systems. The project was part-funded by the Science and Engineering Research Council and the UK Department of Trade and Industry. The industrial partners were Logica Cambridge Ltd and Integral Solutions Ltd.

The two-year project addressed some of the main issues in software project management, such as: cost estimation, benefit analysis, risk assessment, and quality assurance. The overall approach is to accommodate qualitative as well as quantitative measures and most of the proposed metrics rely on the assessment of parameters whose values are on ordinal scales.

At the hub of the various assessments is the so-called Project Model which allows measurable attributes to be placed within a coherent information repository. A good part of this framework has also been implemented as a prototype project information gathering tool by one of the partners.

The Cost Model maps knowledge about the application domain, the development team, the organisational environment and other key indicators onto quantitative bands for required effort.

The Benefit Model assists in establishing a business case, and in assessing the feasibility of a project. Are the benefits going to be tangible or intangible, short-term or long-term, will they be savings in resources or will they assist in opening up new markets?

The Risk Model deals with technological risks, as well as external risks. Its major purpose is to make managers aware of high risk items and, possibly, to assign a "risk vector" to a project. As with benefits, the analysis of risks contributes to the feasibility assessment. Another way of using the risk model is to track progress as far as the overall risk vector is concerned: the project manager may have taken some actions in order to alleviate some risks. Doing the analysis again later on, he can check whether these actions have actually resulted in a lower risk vector for the project.

The Quality Model can be used to establish required quality, such as usability, maintainability, and performance. Comparing the actuals with the required values enables users to monitor the level of quality achieved.

The main deliverable of the project is a handbook which is aimed at practical use and which describes the metrics models and their modes of use and presents the metrics in tabular formats.

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Mathematical Analysis of Software Reliability

by Mark van Pul

Models for describing software reliability are studied at CWI using methods from mathematical statistics. The project is sponsored by the Dutch Technology Foundation STW.

As software systems have increased in size and complexity, reliability tests have become more and more important. Finding the proper balance between development time and reliability is here an important economic issue. Dozens of models were proposed in the last twenty years to describe the evolution of reliability or the error intensity of software during its development and testing phase. Some well-known so-called Error Counting and Debugging Models are the Jelinski-Moranda, Musa and Littlewood models, developed in the 1970s. Some models appear to work very well, but the reason for this has never been understood mathematically.

A special class of such models (including those mentioned above and others), with failure intensities satisfying certain conditions, is investigated at CWI in a project sponsored by the Dutch Technology Foundation (STW) and carried out in cooperation with Richard Gill (University of Utrecht). It has been shown that, for this class of models, asymptotically (i.e. when the amount of data is large) maximum likelihood estimators for the model parameters are consistent and efficient. Techniques have been studied and developed to improve the parameter estimation when the amount of data is restricted. Goodness of fit tests for software reliability models were proposed and their limit distributions derived. Finally, most classical models assume perfect repair and constant software size, thus oversimplifying reality enormously. To this end, a new software reliability model that overcomes both restrictions in such a way that statistical inference remains possible, has been introduced.

This research project aims to shed more light in the mathematical and statistical aspects of software reliability, which is inherently stochastic in nature. It can perhaps offer the software industry an opportunity to control, or to even improve, their test processes better. Industrial interest is always incorporated in STW projects, for example in this case from Philips Medical Systems and Ericsson Telecom.

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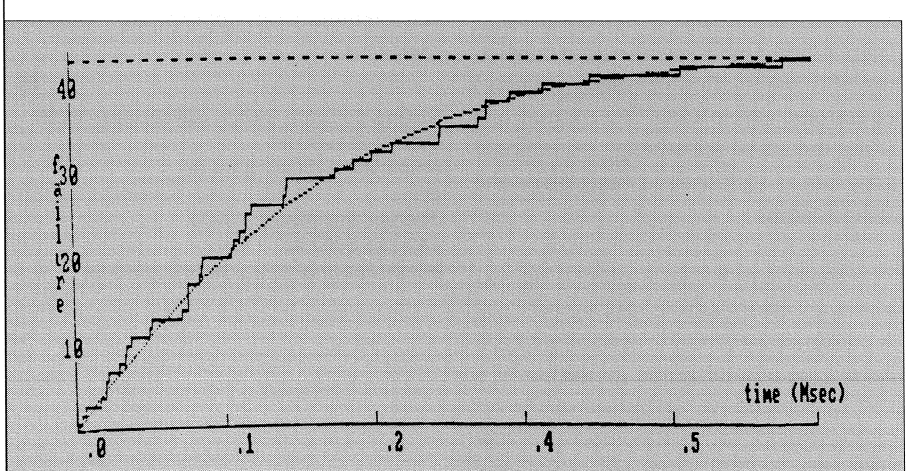

Observed number of failures detected versus testing time for a typical large software project. The dotted curve represents the expected error counting process according to Littlewood's model and maximum likelihood estimation. Important mathematical questions in Software Reliability are how to estimate the total number of faults initially present in the software, and how to predict the test time required to detect, say 95% of them.

A Methodology for Reliable Database Design

by Donatella Castelli and Elvira Locuratolo

A methodology which allows the production of reliable, portable and maintainabledatabase application software is being developed at IEI-CNR, within the ESPRIT BRA Project FIDE (Formally Integrated Data Environment).

The design of a database system consists of three phases:

- Definition of Requirements, in which a model of the world that encompasses the environment of the problem is created,
- Conceptual Design, in which a specification of the system to be built is given, and
- Implementation, in which the database system is developed.

Most current database methodologies are unable to ensure that errors are not introduced when passing from one phase to the next. Our activity is focused on the last two steps of the design process and aims at defining a new integrated methodology capable of guaranteeing the correctness of the database system by formally proving it with respect to the specification.

The methodology being developed is based on a formal system engineering method, the B-Method, introduced recently by J. R. Abrial in collaboration with the BP Research Group. The B-Method sees the construction of a program as an incremental process whose final issue is the implementation. The important steps of this process are the specification construction and the incremental refinement of the specification down to the implementation. The whole process is carried out within the same formal notational framework: the

Abstract Machine Notation. Proof obligations are used to state the specification consistency and the correctness of the refinement process.

In developing our database methodology we have defined a model, called Data Base Abstract Machine (DBAM), which allows data and constraints to be specified with a "semantic expressiveness" which is at least comparable to that of the Semantic Data Models, and provides mechanisms for the incremental definition, structuring and reusability of the specification, which are at least equal in power to those provided by the Object-Oriented approach.

The same model is also used in the refinement process. This process consists of a sequence of steps, each of which produces a DBAM which is closer to the implementation than the previous one. The correctness of a step with respect to the previous one is guaranteed by proving a set of proof obligations. The starting point of the refinement is a DBAM that represents the schema specification whereas the end is a DBAM which can be automatically mapped into different database implementation languages. We believe that certain refinement steps may be rendered completely automatic. For those steps that require designer decisions, we are defining additional proof obligations that come from the particular semantics of our application area and state constraints on the implementational choices of the designer. We are proposing special techniques for these types of proof obligations to speed up the process of proving them. We are also investigating a refinement process guided by optimisation criteria. Finally, we intend to support the methodology with a tool set to cover the whole design process. ■

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Towards the Development of Correct Software: the Korso Project

by Stefan Jähnichen and Jochen Burghardt

Since 1990, the German Ministry of Research and Technology has been funding the project "Korso" which joins 14 mainly academic research institutes and aims at conceiving methods and tools for the construction and analysis of correct and reliable software.

The work at GMD-Karlsruhe is concerned with automating the process of programming-in-the-small. Our aim is to be able to synthesise a program for a "straight-forward" problem from an implicit specification with as little human interaction as possible. This is considered to be helpful in the software production process since, in general, a lot of such straight-forward algorithms are involved which require a large amount of work.

We consider a first-order equational framework, with a specification consisting of a conjunction of (inconstructive) equations. By solving these equations using inductive narrowing, a functional program is synthesised that fulfils the specification.

The main emphasis is placed on automating the inductive solving process. A constructor-based sort system has been developed admitting the definition of a sort by a recursive definition of the set of constructor terms it comprises. New sorts may be built from old ones using (data) constructors. Sorts of arbitrary complexity are expressible, thus reflecting the complexity of terms appearing during the solving process. For example, the set of all binary numbers which contain at least one "0", is expressible; moreover, every finite set of ground terms may be defined as a sort.

The range sort of defined functions is not declared by the user, but calculated from its defining equations - depending on the sorts of the arguments. The effect of this is a potentially infinite overloading, allowing the sort of a term to be calculated with an adequate precision. The right-hand-sides of different defining equations are thus usually equipped with different sorts, allowing the selection of a suitable equation in a solving step by sort determination. In this way, most of the "proper" narrowing steps (i.e. which contribute to the solution term) can be controlled by the sort systems, thus cutting down the search space drastically.

Current research

The sort system shall be further refined to allow for variable bindings (i.e. to calculate different sorts for $x+x$ resp. $x+y$, namely *even* resp. *nat* if x and y have sort nat). This includes the generalisation from sorts as sets of ground terms to recursively described sets of ground substitutions.

In most of the induction proofs, auxiliary lemmas are necessary to "get through" the proof. The problem rather lies in formulating the necessary lemmas than in proving or applying them. We want to experiment with several generalisation techniques to acquire candidates for a lemma from appropriate example instances. ■

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Ensuring and Maintaining Quality through Formal Object-Oriented Design

by Georg Reichwein, Amílcar Sernadas and José Fiadeiro

An object-oriented software development approach is being developed at INESC which promotes correctness with respect to customers' needs, as the main quality factor, and trackability as the key to ensure and maintain quality.

Correctness with respect to customers' needs is the primary quality factor

The notion of quality in Software Engineering is different from the notion of quality in other engineering disciplines. Car builders, for example, have to design their products such that they maintain their original state as long as possible while being used. Software, on the other hand, does not degrade that way: Once written and compiled, a program remains as it is (neglecting physical damage to the storage media). Quality here means matching the customer's needs. According to this view of quality, also software can degrade: It becomes less and less useful as the customer's needs change with time. So, in order to keep the customer satisfied, the software must change. However, how can we maintain quality if we cannot track the changes in the code that are necessary because of the requirements? At INESC, we have been developing a formal object-oriented design approach, OBLOG , which we claim serves the two purposes of ensuring that the delivered product is useful in the first place, and of making a smooth evolution of the product according to evolving requirements possible.

Make sure that everybody speaks the same language

The crucial innovation is to use the same formal language throughout the whole life-cycle of a software project. Such a language has to be flexible enough to be already usable in the early analysis phases, and expressive enough to be usable for detailed design. The idea is to tear down the language barriers between domain experts and system analysts on the one hand, and the programmers on the other. Making them use the same formal language avoids a major problem with (even formal) specification documents: What is actually implemented depends more on the programmer's interpretation of the document than on the specifier's intention. Using a single language, there can be no misunderstandings: we can keep track of changes and design decisions during development, and evaluate their correctness with respect to the original specification. Another advantage is that everybody involved in the process, including the analysts, directly contributes to the final product.

What kind of language can play this role?

We adopted a graphical object-oriented notation for this purpose. The language has to be object-oriented for two main reasons. First, our proposed method is to start system development by modelling the "universe of discourse" (UoD), i.e., by fixing and formalising the part of the real world into which the system is to be inserted. After having formalised the UoD, development proceeds by detailing the specification towards more computational versions of the identified objects, possibly introducing more objects for low-level tests.Whenever it seems appropriate, the actual design can be compiled into executable code.

The object-oriented way to formalise things is most akin to the way we normally perceive the world, and therefore object-oriented models are more likely to capture people's understanding than other kinds of models. Moreover, experience shows that it is much easier to communicate an object model to other people (e.g. staff that is to use the system). For the same reason we advocate a graphical notation: "a picture says more than thousand words". And a graphical notation can be formal!

Quality: a moving target

This is to ensure quality in the first place – now it has to be maintained throughout the life of the system. The maintenance phase is the most costly part of the software life cycle – some studies attribute up to 80% of the total budget of a software project to maintenance. An important part of this effort is caused by necessary evolution of the product. The need for continuous *evolution* of a software system arises from unforeseen (and unforeseeable) changes of the world to which the system is addressed. It is common practice to cope with design errors and changed requirements by re-coding a (small) part of the system. Iterating such changes causes the actual system to drift away more and more from its original design. So, even if the system has been implemented according to a formal specification in the first place, the connection to that specification gets lost as time proceeds.

Maintain the specification, not the code

The OBLOG approach to the "maintenance problem" is to evolve the system not on the level of the code (which is actually unaccessible), but on the level of the specification. This means to go up the "waterfall" to the very top, changing the specification according to the changed requirements, re-design some parts of the system, and then generate a new version of the code. This is possible because OBLOG is supported by a CASE tool that generates executable code from the diagrams. As a consequence, the system is always consistent with its specification, low-level programming errors do not exist (there is no programming), and possible design errors are much easier and much earlier to detect because of rapid prototyping and the highly intuitive and communicable notation.

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Chebyshev Reference Software

by Jan Kok

BCR (the European Community's Bureau of References) is funding a 3-year project (1990-1992) aiming at the development of reference software for the assessment of geometric form from coordinate data gathered by coordinate measurement systems.

In this project, which CWI carries out in collaboration with NPL (Teddington) and PTB (Braunschweig), the assessment will be according to maximum inscribed, minimum circumscribed and Chebyshev (minmax) criteria. Mathematical methods are being developed for the efficient and reliable assessment of a suitable geometric form for a wide variety of sample data sets.

CWI's role is the validation of both mathematical methods and their reference implementations as produced by the partners NPL and PTB. To achieve this, we have constructed and submitted large sets of exact and randomly perturbed coordinate data, in addition to well-chosen data point distributions with supposed difficulties for the developed methods. Care has been taken that a high percentage of the data sets represent realistic data, i.e. data which could have been generated by different coordinate measurement machines. Additional software was developed for the verification of mathematical properties that solutions should possess, and incidentally also for the recalculation of solutions in an alternative way. Feedback was provided to partners through the testing of draft versions of their software and the reviewing of methods under investigation.

The results of the project currently consist of reference implementations in Matlab, Pascal and Turbo Pascal. Production versions will be commercialised by all partners. ■

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Oikos: Software Process for Software Quality

by Carlo Montangero and Vincenzo Ambriola

The interest in explicit models of the software development process is spreading in the software industry. Considerable impetus is provided by large software consumers, like Dod in the USA and ESA in Europe. While the latter is considering a standard model, the former is supporting the process maturity model developed at the Software Engineering Institute in Pittsburgh.

Surely, institutions spending millions of dollars or ECUs in software will regard an explicit software development model as a means of minimising risks by permitting a better control and greater interchangeability of bidders for their contracts.

In any case, the dissemination of process models will have a beneficial impact on the quality of the product itself. For instance, the explicit process model provides a precise context to assess quality measurements with respect to *who* has to perform them, *who* has to assess them and *how* and *where* to perform corrective actions. We cannot discuss here the many approaches to process modelling, which vary both in their degree of formality, and in their goals. We only note that the latter range from

- communication and understanding of (some facets of) the process with no computer support to
- automated support, guidance and control of the staff, and even to
- the complete automation of parts of the process.

The degree of formality is usually related to the goal, as it increases with the level of computer support.

The Oikos project, currently under way at the Department of Informatics of Pisa University aims at the construction of an environment which is sufficiently flexible to experiment the different software processes in use or under development. The environment, for simplicity also called Oikos, is centred on a service, the Process Model Service (PMS), that manages process descriptions and launches them (enacts them, in jargon) as distributed applications on a local workstation network.

PMS also supports the specification and the derivation by stepwise refinements of the executable process. The descriptions of the process are given in terms of simple entities, e.g. roles and services, and of complex entities like (sub) processes and environments. For instance, a role is intended to express the expected behaviour of a person involved in the process, and an environment specifies short-term goals in the process (such as the development of small code units) as well as the tools to achieve them. These entities provide templates of common concepts in software processes and can be composed, after specialisation, to build complex process descriptions.

Specialisation is done in a concurrent logic language that embeds LDL, developed at MCC, at the specification level and Prolog at the enaction level, and is used to describe the behaviour of entities as reactive systems. Several services provide access to repositories of documents and tools, organised according to a basic schema that guarantees an attachment to the underlying operating system. Obviously, these schemas can be extended to cope with the relevant documents of a specific process structure and there are provisions for the integration of new tools.

The underlying enactment machine is close to public release, and definition, animation and the enaction of simple processes are currently being experimented. ■

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Visual Languages for GIS environments

by Irene Campari, Fabio Paternó and Roberto Scopigno

The goal of this project is to make a graphical environment which can interact with Geographical Information Systems (GIS) available to scientists from very different disciplines. The group working at CNUCE is made up of researchers from the GIS field and from the graphical user interface area. Our aim is to introduce the user point of view in the software development of graphical user interfaces in order to improve their usability.

GIS's are complex tools for managing spatial information. They have been developed to satisfy the requirements of applications in many different disciplines characterised by a common need to handle spatial data efficiently. Therefore, the heterogeneous GIS user population requires the development of generalised easy-to-use interfaces that can overcome the barriers imposed by the complex function-oriented design of GIS's.

Visual languages are defined by composing multi-dimensional objects. They have been identified as powerful tools to simplify the task-to-function process. We propose hiding the plethora of basic GIS functions by using a visual language (NetGIS) based on modules which implement a solution to a general subtask and are presented to the user through structured icons. A valid composition of modules connected by links will form an executable network (see figure below).

A module is defined as an elementary software component, implementing a medium level functionality and characterised by a stream of input and output data. Using a data-flow paradigm, the user builds an application by choosing from the set of previously defined modules and connecting them into a direct acyclic graph, whose nodes are the functional modules and whose arcs are I/O port interconnections.

The execution of a visual NetGIS program can be driven under two different policies: user-driven and dataflow. In the former, the system gives users full control over the next module to be executed whereas, in the latter, the system executes a network selecting automatically an ordering on the set of modules allowed by the topology of the specified network.

Graphical editors based on direct manipulation techniques provide comfortable environments for the specification of a visual program but can be more easily a source of mistakes. A formal specification of the visual language has been made to prevent implementation errors during the design of the visual editor.

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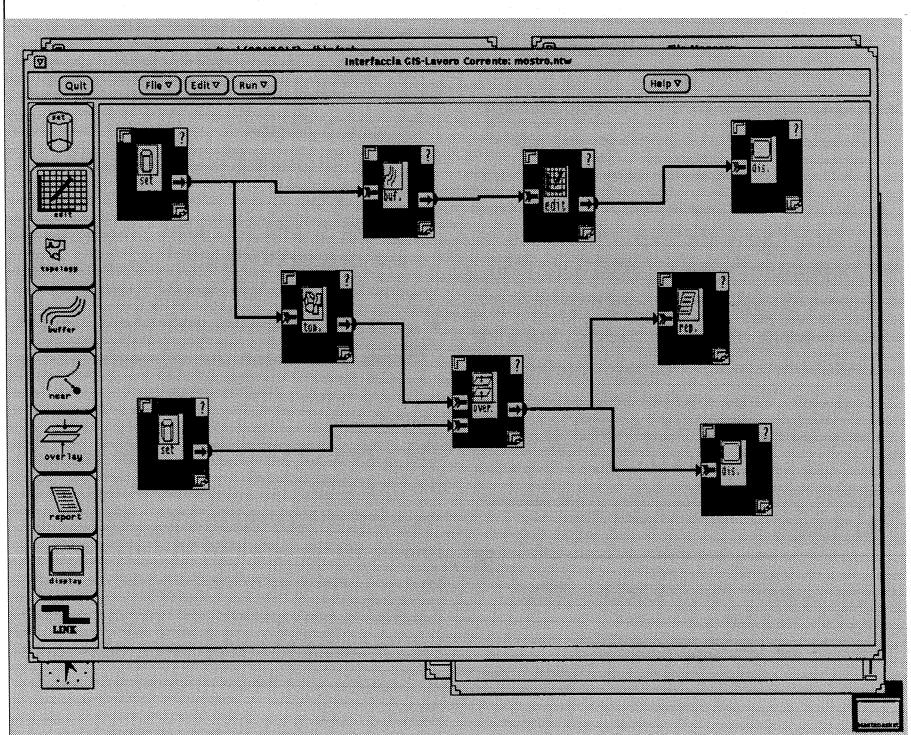

Network of modules

The Assistant Computer: A New Generation of Support Systems

by Siegfried Münch

The Assistant Computer is designed to facilitate a new division of labour between man and machine. The GMD Institute for Applied Information Technology has been developing the first prototypes of such systems for personal computers.

As its name implies, the Assistant Computer is primarily intended to assist the user, and not to automate procedures. While the system will perform a greater number of tasks than computers have done in the past – and in particular those tasks which the user finds onerous and

difficult –, it is nevertheless not the aim of the Assistant Computer to transfer as many tasks as possible entirely to the machine, i.e. to automate.

It is a fact of many fields of computer application that, owing either to the enormous complexity of the problems to be addressed or the manifold guises in which they can appear, all attempts to develop an automatic system fully competent to solve problems are doomed to failure. What is needed instead is a coordinated set of tools, which users can combine, adapt and apply in the manner they feel is most appropriate to each individual problem. With this in mind, the aim of Assistant Computers is precisely not to cover and resolve all problem eventualities with fully autonomous systems.

The Assistant metaphor expresses not only the leitmotif of GMD efforts as a whole, but also the aim to build systems whose behaviour is characterised by user-assistant traits. A good assistant will thereby combine a number of qualities. In the case of a human assistant, for example, it is naturally expected that he or she will be competent in their specialist field, will know the limits of their competence, will be able to interpret imprecise instructions, adapt to their superiors and learn from them, and at the same time explain the thinking behind their own behaviour and proposals. The support of communication and cooperation activities is equally a central function of assistants in administration. This type of assistance can be targeted all the more effectively the better the assistant knows his client.

In the figure of the Assistant Computer, however, GMD scientists are not seeking to build an imitation human assistant. Rather, they are attempting to reproduce, in a machine system, some of the qualities which are necessary or useful for assistant functionality. If computers are to provide assistant services, they must be able to be furnished both with expert knowledge and with knowledge of their user. And that is not all: systems also require knowledge about themselves - about their own functioning, in other words. Only if a system can monitor its own behaviour and reflect upon its actions will it be able, for example, to evaluate its competence and explain its behaviour correctly.

The GMD Institute for Applied Information Technology is currently working on the following properties characterising Assistant Computers:

- Expertise: Assistant Computers should be able to be furnished with expert knowledge in specific fields of user importance, and be able to provide support in the solution of problems in these fields.
- Knowledge of the limits of their competence: Within their domains, Assistant Computers should be able to supply information regarding their competence and its limits. The user should thus be able to find out, in dialogue with the system, which problems the system can solve, which not, and why not.
- Learning ability and adaptive behaviour: Assistant Computers should be able to adapt both their behaviour and their services to the individual needs and personal style of the user. The system should learn from the user by observing and analysing his work.
- Interpretation of imprecise instructions: Assistant Computers should be able to interpret incomplete, vague, ambiguous and even contradictory instructions on the basis of their knowledge about the user and the task currently in hand.
- Explanation capability: the systems should be able to explain and justify each of their actions, conclusions and instructions, in a manner which is comprehensible to the user.
- Cooperation support: Assistant Computers should support not only the isolated work of the individual, but also collaboration within teams and organisations. They should help to coordinate labour-shared tasks and maintain the organisational knowledge required for the purposes of cooperation and coordination.

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Multimedia and Geographic Systems at IEI-CNR

by Benedetto Biagi

A research activity is now under way at IEI with the aim of formalising particular aspects affecting the possible integration and extension of hardware/software technologies used in multimedia and geographic information systems. In particular, attention is being given to user interfaces and the integration of "media" for the specification of a Multimedia GIS prototype.

The main considerations on which the research is based can be summarised as follows:

- the two technologies have numerous points in common (e.g. the large quantity of data to be handled, their management by database structures);
- like all structured and complex management systems, GIS could gain considerably from the introduction of user-friendly interfaces typical of multimedia systems;
- the direct management of distributed networks of active and passive sensors is to be expected in the near future; such networks could be usefully integrated in the multimedia context;
- many multimedia applications could benefit from the use of territorial or geographic information.

These considerations are at the basis of the formulation of hardware and software specifics which take into account the actual tendency towards the standardisation of system components such as database query languages, graphical user interfaces, graphic and cartographic data encoding, and data compacting procedures.

Questions related to the management of different media are now being addressed,

such as the integration of the functions needed by the user to process data coming from different sensors, both analytic data (from monitoring networks) and all kinds of remote sensing data (e.g. live video images in the visible wave length range, or infrared images), thus facilitating the execution of complex tasks.

Particular attention has been given to the contribution that multimedia technologies can make to improving GIS user interfaces. Through the extensive use of windows and icons and adopting object oriented programming, more friendly user interfaces can certainly be created. Our objective is to specify "how" this is possible, considering in particular the most frequent operations performed by the GIS users and rendering the execution of iterative operations as simple as possible.

Another very interesting point which is now being studied is that of spatial indexing. The mapping from a point in geographic or Cartesian coordinates (also in 3D) to an efficient database index remains an open problem.

Multimedia technology uses Hypertext as a fundamental component, and this permits the user to navigate through a document in an easy but significant way. Studies on the possibility of a "Hyperspatial" geographic indexing, similar to a multimedia Hypertext, are now being made at IEI and the first results are expected for the end of the year.

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Typed Lambda Calculi

by Henk Barendregt and Marc Bezem

A taxonomy of typed lambda calculi is studied in a project carried out at the universities of Eindhoven, Nijmegen and Utrecht and supported by the European Programmes SCIENCE and ESPRIT. The study of such calculi is relevant for the programming of parallel computers and for automated proof checking.

Lambda calculus has been developed in the thirties by Church, initially as a foundation for mathematics. This attempt failed due to what is now called the Curry paradox. However, lambda calculus turned out to be an interesting computational model, equivalent to computability by the Turing machine. In this way the lambda calculus became the prototype of an untyped functional programming language. Operational and denotational semantics for this calculus became exemplary for other programming languages, including imperative ones.

In the 1940s, Church and Curry initiated the study of typed lambda calculi, in which lambda terms are classified according to their applicative behaviour. In the 1960s Curry, de Bruijn and Howard discovered that the types of typed lambda calculi are in fact appearances of logical propositions. Thus there are two possible views on typed lambda calculi:

- as models of computation, where terms are viewed as programs in a typed programming language;
- as logical theories, where the types are viewed as propositions and the terms as proofs.

Present-day research focuses primarily on typed lambda calculi. For example, the Dutch National Typed Lambda Calculi Project has as primary objective to investigate and refine the so-called Lambda Cube, a taxonomy of typed lambda calculi based on which (lambda) abstractions are allowed. This project is carried out in collaboration with the Universities of Utrecht (Faculty of Philosophy), Nijmegen (Faculty of Mathematics and Computer Science) and Eindhoven (Department of Computer Science). It is financed primarily by the Netherlands Organisation for Scientific Research (NWO), the Netherlands Computer Science Research Foundation (SION) and by the cooperating universities. The NWO/SION financial contribution adds up to approximately 4 full-time equivalents. Additional support has been given by other funding institutions, including SCIENCE (Twinning: Lambda Calcul Typé), and will be given by ESPRIT BRA (Types for Proofs and Programs). An international conference is scheduled for March 1993 (see announcement in section Events).

Spin-off

The lambda calculus treats computations as a series of replacements preserving meaning. Therefore algorithms expressed in functional programming languages are mathematically more succinct than imperative programs. Prototype implementations of these languages have reached impressive efficiency and appear promising in view of programming parallel computers.

Typed lambda calculi as logical systems are the basis for several systems of automated proof checking. Because of present-day computer power these checkers can also be used as interactive theorem provers. Several prototypes are presently available. Links with systems of computer algebra look promising.

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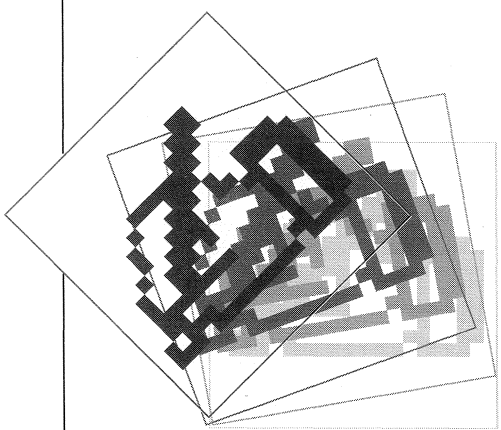
A Hyper-Media Approach to the Multi-Authoring and Reading of Documents



by Victoria A. Burril

In common with many computer-based working environments, we have a culture within the Informatics Department at RAL of sending copies of papers and reports to various people within the department and asking for their comments. We would like to be able to do this multi-authoring and reading exercise entirely on-line, and do indeed have access to many (sometimes isolated) software tools that could be components for such a system. However, a fully integrated multi-authoring tool with the potential of becoming widely accepted does not yet exist.

The purpose of this article therefore is to encourage reactions, comments, and outline solutions that other ERCIM institutes have to such a system, and to present some of our own ideas.

Purpose and Structure of the Document

It is often important for the author to add meta-information such as the intended "audience" of the document (and hence technical level), and the deadline for comments. Although this meta-information is not part of the document itself, it is nevertheless important in enabling readers to assess the document (and their own comments as well).

The physical thickness of paper is an immediate clue as to the length of the document and hence whether it can be read in 5 minutes or 5 hours. The thickness of paper before and after the current page gives the reader an indication of how far through the document they have read. These physical clues, coupled with logical clues such as contents pages and running heads, are all very valuable (if unconscious) clues into the document. Substitute methods would be highly desirable for documents presented on the screen.

Commenting on the Document

The normal method of entering comments is via the keyboard, and readers would probably expect some form of window to appear into which the text can be typed. On completion of the comment, a marker can be placed at the appropriate position in the main text. These marks can then be used by the originator of the document as indications of particularly problematic sections of text, or filter the marks according to creator so that, for example, comments from a particular colleague could be incorporated first.

Other Data

Within Informatics, we are looking at the use of three non-textual media in the document editing task. Firstly, a PUI (Pen User Interface) in an essentially note-taking environment where only bit-maps of the writing, not semantic interpretation, are required. This would be suitable for straightforward proofing marks, but less so for more lengthy comments. Secondly, the use of audio capabilities of SUN SPARC machines and the possibility of voice, sound and music integration. And thirdly, the possibilities of incorporating video, such as people's reactions during human-factors experiments, or videos of technical meetings and seminars.

■

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GMD Takes Part in International Cooperation on Formal Specifications

by Heinz-Jürgen Burkhardt

Scientists from the GMD will be taking part in MUTEST (Mutual Testing of Formal Protocol Specifications), an international research initiative which will test the consistency of formal specifications of the same protocol in different languages – e.g. LOTOS, Estelle, Petri nets – both mutually and with existing, and in particular standardised, test suites.

Underlying the initiative is the heuristic aim to build upon the automatic generation of test suites currently being attempted in many places and to check each formal specification using the tests deduced from the other specifications. More than 20 projects from all over the world wish to take part in this venture, whose technical and organisational details were outlined at a meeting on 3 and 4 February 1992 at the GMD Institute for Telecooperations Technology in Darmstadt. The GMD, from whom the idea for the programme first originated, is represented on the Steering Committee by Heinz-Jürgen Burkhardt and on the Organising Committee by Bernd Baumgarten.

■

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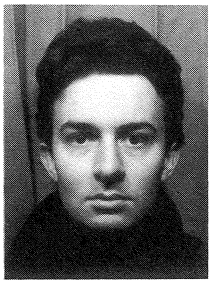
Award for Excellence in Numeric Intensive Computing

Jean-Jacques Codani



Bruno Lacroix

by Jean-Jacques Codani

The 1991 IBM first prize for excellence in France, comprising of 80000FF, was awarded to the author, a researcher at INRIA, and Bruno Lacroix, working at the CEPHB-GENETHON laboratories, for joint work done on the computational aspects of physical mapping of the human genome.

Physical mapping of the human genome is used in an attempt to order DNA fragments – clones – by measuring their overlaps. A matrix of relative overlap probability (likelihood ratio) for each pair of clones is built using a probabilistic model based on Bayes theorem.

The amount of data and the complexity of the model imply intensive numerical computation: for the current data the computation for 20000 clones requires one month of SparcStation2 CPU time. Slight changes in data or sophistication of the model quickly leads to unbearable execution times.Attention was therefore focussed on approximations and, in particular, exploitation of the intrinsic parallelism of independent pairwise comparisons.

As a result, the same C code can be compiled and run on Unix workstations, heterogeneous networks – using portable communication toolkits and machine independent data encoding – and MIMD computers (message passing and shared memory architectures). Near perfect speed-up is achieved whatever the number of processors. This software, yielding promising results is also a good platform for the implementation of pairwise comparison algorithms on parallel architectures.

The physical map of the human genome will become a powerful tool for identification of unknown genes, particularly those responsible for genetic diseases. ■

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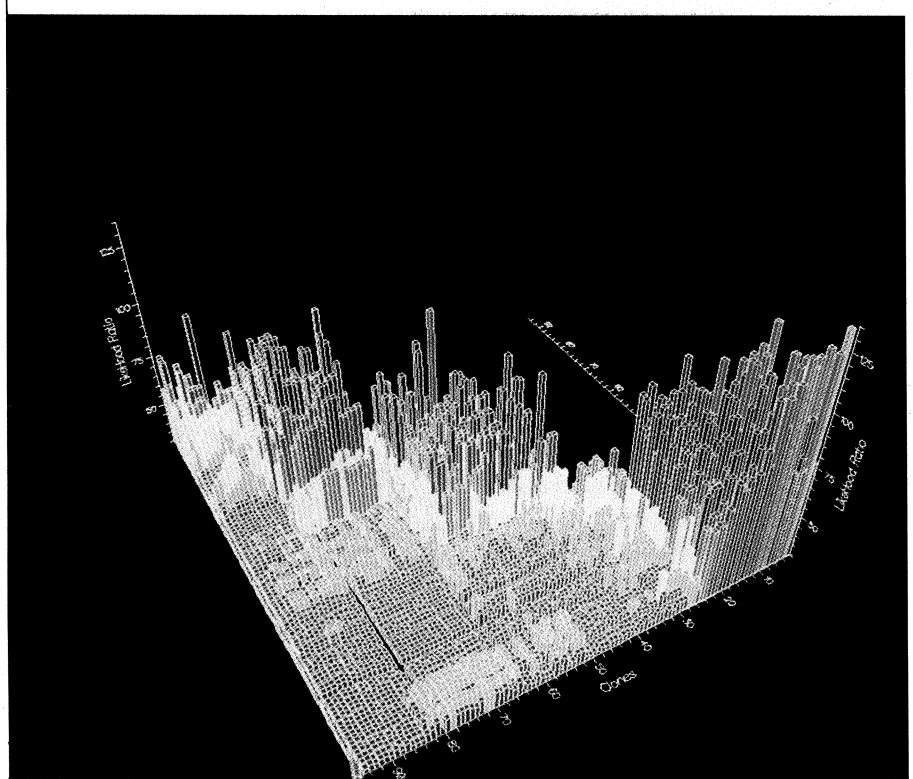

The plot gives a three-dimensional view of the computation of the likelihood of pairwise overlapping of a collection of 96 clones. The two axes *(x,y)* represent the clones, the *z*-axis is the coefficient expressing the likelihood ratio calculated between two clones. The higher the "block", the higher the probability of overlap. (Photo: Alexandre Eidelman - INRIA)

Formal Methods into Practice: B User Trials

by Juan Bicarregui

The "B-Tool" and "Abstract Machine Notation" have been developed over recent years by Jean-Raymond Abrial in conjunction with the Programming Research Group at Oxford University and British Petroleum Research at Sudbury, UK. Together they provide a methodology and support environment for the formal specification and verifiable construction of software systems.

A new collaborative project is beginning at RAL to subject the B Abstract Machine approach to industrial scale case studies. The project will encompass four case studies which will expose the method and tools to a range of technical problems drawn from both industrial and research sources. It will also develop training courses in B technology as well as evolv-

ing the existing support in the light of requirements drawn from the case studies.

RAL's participation will involve one of the case studies and investigations into the methodology employed in the construction of proofs.

RAL's case study will be chosen in the area of specification of graphics standards where a body of comparative knowledge is developing in the application of different formal approaches. The case study will be used to compare the effectiveness of the B method with the previous experience of using other languages.

The investigations into proof construction will be focused on the use of "theory structuring" to facilitate the proof process. Common practice in the usage of the B method is to adopt a "lazy-evaluation" approach to proof: proof obligations are generated and then their proofs constructed through goal-oriented backwards reasoning. RAL will investigate the possibilities for the re-use of parts of specifications and proof arising from the incorporation of a formal hierarchically-structured theory store.

The other partners in the project are: British Petroleum Research, Lloyds Register of Shipping, Program Validation Limited and the Royal Military College of Science.

■

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Distributed Real-Time Fault-Tolerant Computing Systems

by Gérard Le Lann

Research and development activities conducted within project REFLECS concentrate on those algorithmic issues arising with Distributed Real-Time Fault-Tolerant computing systems. The major outputs of the project are algorithms and protocols, as well as analytical models and behavioural/performance data. The project is sponsored by ESPRIT.

REFLECS 1 : Fault-Tolerant Distributed Computing

The notion of distribution used in project REFLECS is that defined in the mid–70's, i.e. control of concurrent asynchronous activities in the absence of global system state. Obviously, we do not equate distribution with networking or openness. It is assumed that processes can exchange messages and that faults can occur at random. We consider crash, omission and timing failures. Under such assumptions, we are interested in proving the existence of specific properties, such as global safety or global liveness, for time-bounded systems.

Concurrency control and reliable consensus algorithms are being investigated. Accurate analysis of published solutions to the reliable/atomic broadcast problem reveals flaws or tautologies or solutions that fail to meet a number of properties. On going work concentrates on designing correct atomic broadcast protocols.

REFLECS 2 : Real-Time Distributed Computing

In the area of real-time systems, we are addressing design issues raised when assuming incomplete a priori knowledge (e.g. arrival laws, fault patterns,...) which, we believe, is consistent with the notion of distribution. Conventional approaches being unapplicable, we are investigating time-dependent scheduling algorithms based on generalised deadlines, such as time-values functions (TVF). In order to break the complexity (NP) of the scheduling problem, we have developed heuristics based on TVFs whose time complexity is $O(n^3)$, for n tasks. These heuristics yield process schedules whose "distance" from optimal schedules is analytically bounded for a number of tasks of practical interest. We are also investigating how to integrate time-oriented scheduling, fault-tolerance and concurrency control. This issue is generally ignored with conventional approaches, where concurrency control is assumed to be taken care by some synchronous hardware. Finally, some recent work has focused on algorithms for synchronising multiple physical clocks deterministically and statistically. More precisely, our deterministic algorithm is able to achieve a worst-case precision that is roughly equal to the optimal lower bound (as established by Lynch and Lundelius).

REFLECS 3 : Communication Protocols

We are mainly investigating the shared channel multiaccess problem. Our approach is based on contention protocols (a la Aloha or Ethernet). Several classes of such protocols have been devised for "conventional" channel speeds (e.g. Ethernet category), that are probabilistic or deterministic – possibly for wireless networks – as well as for "high speed" channels (e.g. 1 Gbits/s). We have shown that convention-based protocols are best suited for rigorously satisfying timing constraints whenever it is impossible (or unwise) to assume full a priori knowledge regarding message arrival laws and/or fault patterns. This is the case with networks or mobiles, where connectivity varies permanently. Our major current effort on this topic takes place within the framework of Esprit 3 (Project Laura).

■

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Fifth Generation Computing Systems: The Achievements of a ten-year Research Program

by Alain Michard

A large international conference was organised on 1–5 June in Tokyo during which the main achievements of the well-known Japanese project were presented and demonstrated. The FGCS Project was launched in 1982 for a ten-year period. A specific laboratory, ICOT, was established to carry out the research activities. This laboratory was created with about 40 researchers and now gather about 200, including some foreign visitors. During the 10 last years, ICOT had several collaborations with European research organisations (mainly in UK, Sweden and France), and with some US laboratories .

Seen from the scientific point of view, the basic framework of the fifth generation computer is parallel processing and inference processing based on logic programming. The main technological achievements are the following (the list is not exhaustive):

- A line of parallel machines, from workstations to mainframes, dedicated to symbolic processing. The last and most powerful one, named PIM-m, is an MIMD machine with 256 processors spread in 32 cabinets. The network is a 2-dimensional mesh with a bandwidth of 4.2 MB/s x 2 directions/ch. Each processor is controlled by microprogram (64 bits/word x 32K words). The data width is 40 bits/word. Cycle is 58 ns. Cache memory is 1 for instructions and 4 KW for data, and local memory is 16 MW (40 bits each word). This machine has a peak performance of 100 MLIPS, which is approximately equivalent to 10.000 MIPS. The machine is designed to run efficiently the KL1 language.
- KL1, a "high-level machine language". It is in fact an AND-parallel logic programming language. The language processor includes an automatic memory management mechanism (distributed garbage collector), and a dataflow process synchronisation mechanism.
- PIMOS, an operating system for the PIM machines, written entirely in KL1. Management and control mechanisms are implemented using "meta-call" primitives of KL1. Functions for resource management and execution control of user programs were designed as independent from the architectural details of the PIM hardware (non-centralised management scheme). PIMOS is therefore intended to be a standard parallel operating system for large-scale parallel machines used in symbolic processing.
- Parallel KBMS/DBMS: Kappa-P and Quixote. Kappa-P is a database management system based on a nested relational model. The upper layer is deductive object-oriented database. It is accessed by the application programmer using a knowledge-representation language: Quixote.
- Knowledge processing softwares, including theorem provers (inference mechanisms), and a parallel constraint logic programming language, GDCC. All these tools are implemented in KL1.

All these hardware and software technologies form in fact a very integrated and elegant system: the overall design has been made around and with the KL1 logic programming language and its associated processor, thus leading to very good efficiency of the system as a whole.

Several applications were also demonstrated. In addition to their intrinsic interest, they also demonstrated the usability and efficiency of the PIM machines and associated basic software and programming environment to develop symbolic applications. The most noticeable were a natural language processing system for Japanese language, a parallel VLSI-CAD system, a legal reasoning system, and a genetic information processing system developed in collaboration with Argone laboratory in the US.

In parallel with the general conference, the MITI organised a half-day evaluation workshop, during which twenty foreign researchers from USA and Europe were asked to prepare and comment an assessment report of the FGCS Project. All these reports and comments were very consistent in their agreement that FGCS had been a major scientific and technical success, and that it had strongly contributed to make of Japan (and especially of ICOT) a major partner in CS research in parallel systems, concurrency, architectures, languages, and artificial intelligence. It was also pointed out by most of the participants that the Project had boosted R&D in symbolic processing all over the world. It was stated that national and international programs in other parts of the world (e.g. Alvey in UK, ESPRIT in Europe) had been up to a large extent decided as local "answers" to the Japanese initiative.FGCS therefore had played a major role in making of intensive symbolic processing a major scientific challenge.

During the plenary session, the Ministry of Industry announced as a major political decision that all the ICOT developed software will be available free of charge in source form, without any restriction as to use, modification, copying, expanding, etc. The catalogue of this free software describes more than 70 "products". As a consequence of this decision, ICOT, during the next years, is going to port KL1 on other parallel machines than the PIMs, and especially on architectures built with commercially available RISC processors. ICOt will also provide English documentation enabling foreign organisations to port the software themselves on other platforms.

To conclude, I would like to quote a sentence from David Kahaner (ONR, Asia) on which I fully agree: "The FGCS'92 conference is one of the best planned and executed international meetings that I ever attended". I would just like to add that the warmth and graciousness of the reception hosted by our Japanese colleagues was also of the highest quality. ■

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A new basis for German-Canadian cooperation: Monique Lefèbvre, president of the Centre de Recherche Informatique de Montréal, and Prof. Dr. Dennis Tsichritzis, chairman of the board of the GMD, sign the cooperation agreement. (Photo: Münch, GMD)

German-Canadian Cooperation Agreement Signed

by Gilbert Kalb

A framework agreement on cooperation between the GMD and the Centre de Recherche Informatique de Montréal (CRIM) in Québec, Canada, was signed on 6 February 1992 at GMD Birlinghoven, thereby placing the cooperation which has been growing over the years between the GMD and Canadian research institutes on a new basis.

CRIM is an independent non-profit corporation. It was founded in 1985 with the declared aim of bringing together research activities from the worlds of industry and higher education. Half of its funding comes from public sources, half from company contributions.

A seminar held on 4 and 5 January 1992, organised by Jan de Meer of the GMD Research Institute for Open Communications Systems (FOKUS), reported both on joint projects by CRIM and GMD and on potential areas of new collaboration between the two research bodies. Participants included representatives from research and industry from Germany's old and new Federal states. The seminar's main emphasis fell upon the field of software engineering, and in particular the development of open communications systems.

There were lectures on the following topics:

- object-oriented descriptions for validating OSI applications;
- building OSI interfaces;
- performance of multicast switching and of ATM multiplexing;
- software process and CASE environments
- CASE impacts on software systems development capability;
- implementing CASE technology into the maintenance process through reverse-engineering E/R models.

It is aimed to involve research institutes and industry from both Canada and Germany in future collaborations. It was unanimously agreed that the conclusion of the framework agreement and the seminar in Berlin represented a significant step towards this goal. ■

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Franco-Spanish Collaboration

by Michel Bernadou

The 5th Franco-Spanish Autumn School on "Numerical Simulation in Physics and Engineering", held every two years, will take place at Castello de la Plana, Spain from 28 September to 2 October this year. The event is organised jointly by INRIA and five major Spanish universities.

This Franco-Spanish collaboration initiative was launched in 1982 as the result of intense collaboration which existed between mathematicians and engineers in the two countries in the field of Applied Mathematics. This collaboration is of great importance, particularly with regard to the close collaboration in European community research programmes such as SCIENCE and ERASMUS.

The objectives of the schools are to

- give an introduction to Numerical Simulation in directions currently developed by the scientists within the two countries;
- serve as a meeting place for researchers, professors and professionals of the two countries;
- illustrate the applications of Numerical Simmulation in French and Spanish industry and enterprise.

■

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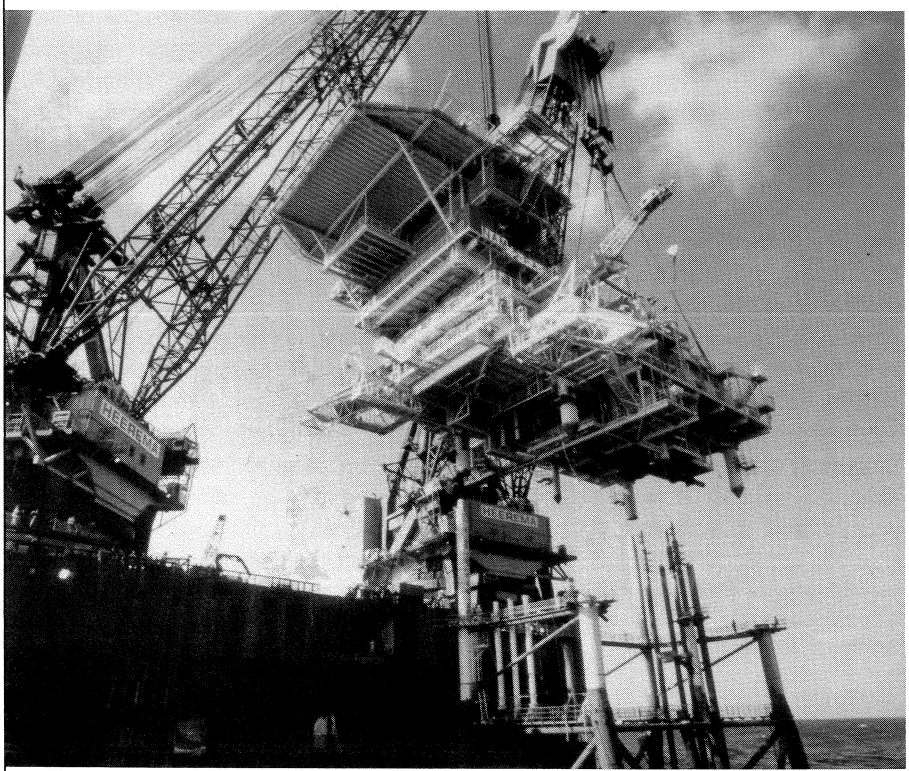

Construction and installation of offshore platforms is a complicated and costly business, and so is their maintenance. CWI research, in the form of a Shell fellowship, deals with the theoretical foundation of maintenance optimization by studying certain queueing models.
(Photo: courtesy NAM, Assen)

Maintenance Optimisation: a Shell Fellowship at CWI

by Henk Nieland

The effect of maintenance manning levels on maintenance backlog and system availability/effectiveness is studied with a queueing model developed at CWI. The project is carried out in the framework of a Shell fellowship.

In a two-year project sponsored by Shell at CWI, research is carried out in the theoretical foundation of maintenance optimisation through the development of novel mathematical techniques. The research is relevant to, e.g., determining minimum maintenance manning levels for offshore installations. It concerns in particular the formulation and subsequent study of a queueing modelswhich are expected to yield insight into the effect of maintenance manning levels on such aspects as maintenance backlog and system availability/effectiveness.

Current models predict the annual expected maintenance workload without taking into account its sometimes very uneven distribution over the year, for example due to bad weather. Although some maintenance backlog is acceptable and even desirable, it should clearly not become too large either. One of the proposed models for backlogging maintenance tasks involves two queues for preventive and corrective maintenance, with a possible overflow from the first to the second queue. The problem is formulated in the framework of Markov processes and is solved numerically. The project will run until August 1992.

Shell fellowships started at CWI in 1987. During a two-year period the fellow participates in CWI's research programme, the subject being agreed upon by both parties. The resulting know-how is, in principle, available to industry at the end of the contract period. Previous subjects involved Inverse Scattering and Image Processing of Seismic Signals, and Combinatorial Algorithms for Planning and Scheduling. ■

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Study on Massively Parallel, Optical and Neural Computing published in the USA

by Hans-G. Klaus

GMD Berkeley has published a study on "Massively Parallel, Optical and Neural Computing". The authors, Gilbert Kalb and Robert Moxley, are members of the GMD's Department of International Affairs.

The study contains information on prototypes and commercially-available hardware and software. It describes relevant research activities being undertaken by laboratories, universities and specialist industries. It concludes with a useful bibliography, list of contact addresses and a glossary.

The results of the study were supplied to all professors of computer science in Germany as a service of the GMD. A similar investigation into the situation in the same research field in Japan is currently under way in the GMD's Tokyo office, and will be completed in the course of 1992. ■

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TTC: The Transputer Consortium

by Raymond Fawcett

A new organisation of transputer users and suppliers was launched at the closing symposium of the RAL-based SERC/DTI Transputer Initiative in Reading on 30 and 31 March 1992.

TTC (The Transputer Consortium) describes itself as "the international community of transputer users and suppliers cooperating to increase their effectiveness through joint action, mutual support and sharing knowledge". Its initial funding is from participating supplier companies and it has the additional non-financial support of user groups. Representatives of the first sponsor companies (Inmos, 3L, Parsys, Parsytec and Transtech) and of WoTUG (the World Occam and Transputer User Group) were present at the launch. TTC will be run by a secretariat based at RAL and overseen by an executive board representing the sponsors and affiliated user groups.

TTC's objectives include:

- influencing the development of transputer products by ensuring suppliers have a complete picture of users needs,
- developing and promoting standards within the transputer user community,
- providing a forum for sharing knowledge and experience and
- promoting standards of technical and professional excellence amongst its members.

In order to meet these objectives TTC will publish a quarterly journal, organise an annual international conference and exhibition, promote transputer education, organise a standards forum, compile and manage consultancy and product directories, foster links with professional bodies and promote local and national meetings.

The TTC journal will absorb the current SERC/DTI Transputer Initiative Mailshot and the WoTUG Newsletter. Each issue will be about 250 pages long and will include refereed technical papers, technical articles from sponsors, an editorial, user group news,hints and tips, diary and letters sections.

The TTC conference and exhibition will be the World Transputer Congress: the merger of the highly successful Transputer Applications and Transputing series. The first World Transputer Congress will be held in Aachen in September 1993. Membership of TTC is open to any individual or organisation with a legitimate interest in the use, development and promotion of transputers. ■

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Quality in Software: Breaking the Wall

by Antonia Bertolino, Piero De Risi, Mario Fusani

QUALITAL is a University Consortium in Quality Engineering founded in 1989 as an initiative of the University of Pisa. It consists of the major Italian industries and universities and its main objective is the spreading of a quality culture.

When in 1990 the QUALITAL Consortium decided to include software technology as one of its targets, successfully organising the International Conference "Achieving Quality in Software" (Pisa, 22 -24 April 1991), the executive board did not fully realise that hard times were about to begin for this new task. As the data and experience acquired by the experts of the Consortium in a number of companies (both associated and external), willing to make their products more attractive, was collected and analysed, it became increasingly clear that quality could not just be stuck on to a project software where previously it was lacking. This confirmed the state-of-the-art in software engineering: considerable commitment is necessary, at all levels, in any organisation which intends to increase the quality of its products and services. Consequently, the software production activity must be transformed by the establishment of a controlled and improvable process.

This situation is no different from what has happened for decades with other technologies. QUALITAL reports tell us that software is still somewhat difficult to manage: a solid "wall" of self-confidence seems to protect the behaviour of many software teams, and top managers often fail to understand the inner reasons which determine the quality, cost and duration of a project. It turns out that most producers are reluctant to approve expenses to renew their software process, for these would be charged to current projects, and this is unacceptable in an industrial economy looking for short-term returns on their investments.

To carry out its arduous mission, QUALITAL has joined the Software Quality Group of IEI-CNr, which works with Independent Verification and Validation (see ERCIM News 7, September 1991). The first task is to persuade some QUALITAL companies to have their software process assessed and possibly changed. Costs would be reduced by centralising the efforts in the Consortium. The action would then be extended, with enhanced experience, to the wider industrial community.

Getting the "mature" members of QUALITAL to cooperate in the job does not seem an easy task (another wall?). If they cannot be convinced of the common benefits, another basic method of persuasion could be exploited to its full power to break the wall against interventions for quality: if products and services are not aligned with some defined soon-to-arrive standard, for instance EC standards, then, in the mid-term, the company will no longer be there for further commercial efforts. ■

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ICSI: Successful German-American Cooperation in the Field of Computer Science

by Siegfried Münch

The results of a joint project incorporating science, state and industry to intensify German-American cooperation in the field of computer science, together with the project's significance for research policy and its future prospects, formed the central topics of discussion at a status seminar hosted at the GMD's Schloß Birlinghoven facilities. The International Computer Science Institute (ICSI) in Berkeley, California, and the Society for the Promotion of German-American Cooperation in the Field of Computer Science and its Applications, in conjunction with the Federal Research Ministry, presented the scientific results achieved since 1988 and examined the performance of the Institute of Science and Industry in Germany.

The International Computer Science Institute was founded in 1988 at the instigation of the GMD, the Federal Research Ministry and the University of California in Berkeley. Described by Chancellor Kohl during his visit to California as "a leading example of German-American scientific cooperation in action", and one which "should inspire similar ventures in other areas of science and in other locations", the ICSI sees scientists from Germany working, for limited periods of time, alongside American colleagues on joint research projects in the fields of artificial intelligence, the application of massive parallel processing, high-speed networks and large distributed systems.

The returns of the last three years have been considerable. According to Prof. Dr. Heinz Schwärtzel, president of the Society for the Promotion of German-American Cooperation, the ICSI has succeeded in building up a highly-qualified research and development capacity even within this relatively short space of time. Under the direction of Prof. Dr. Jerome Feldman, renowned international researchers are working in a range of future-oriented fields, such as the problems of massive parallel processing in large distributed networks – the Institute's special area of interest – and the development and implementation of high-speed networks and multi-media applications. Individual aspects of the overall project are divided between four, closely-coordinated groups: "Artificial‘intelligence and applications of massive parallelism", "Realisation of massively parallel systems", "High-speed networks and comprehensive distributed systems" and a "Theory" group.

The Institute currently comprises of sixty permanent staff members, post-docs, visiting researchers and students. 70 German computer scientists came to work at the Institute during its first three years. A total of 20 German post-docs have been selected to spend a "research year" at the Institute up till now. Some 50 visiting German professors and senior scientists have spent an average of three months at the Institute developing their contacts in the USA. As part of a "Summer Internship Program", twenty young computer scientist graduates from American universities have also been given the opportunity to work in German companies. In the opinion of experts from science and industry, the ICSI's activities have thereby grown to represent the most important German-American scientist exchange programme on the west coast of the USA. Person-to-person innovation transfer is thus already fully operational. ■

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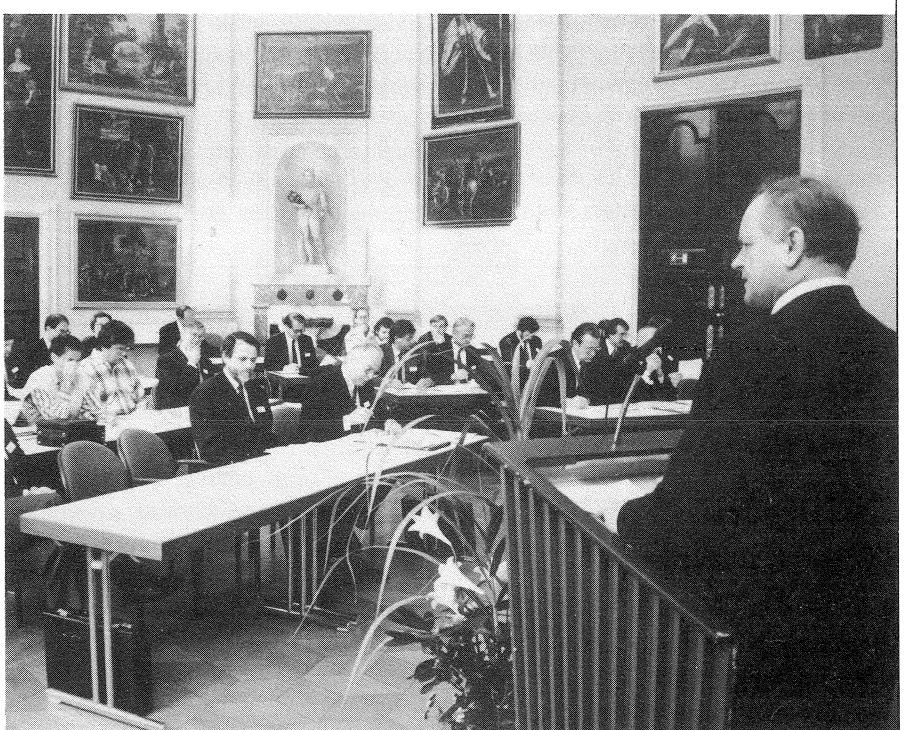

Considerable returns for the International Computer Science Institute: Prof. Dr. Heinz Schwärtzel opens the status seminar. (Photo: Münch, GMD)

Parameter Identification in Reaction Kinetics

by Henk Nieland

In a consultation project with the multinational chemical company, AKZO, CWI has reactivated earlier research in parameter identification in large systems of differential equations. A novel aspect is the interactive use of numerical algorithms.

Many dynamical processes in a chemical, biochemical or pharmaceutical setting are modelled mathematically by a set of differential-algebraic equations. In general, these models are of a complex, non-linear nature. They contain a number of unknown parameters and it is an important issue, theoretical as well as practical, to validate these models and to determine parameter values from experimental data. In addition, it is important to know if such a determination is possible on the basis of the available data. Moreover, if the model fits with the data, it is important to distinguish possible dependencies between the parameters.

A one-year research project was commissioned by the Dutch company, AKZO, at CWI last year (running till August 1992) to study parameter identification in reaction kinetics models. Mathematically, these models consist of a large system of non-linear differential-algebraic equations and initial conditions, containing a finite number of parameters subject to certain constraints. The differential equations are in general "stiff", i.e. their solution consists of components varying slowly and rapidly in time.

Such problems were addressed by CWI in the 1970s and software was developed, written in ALGOL 60. This program has presently been adapted and made operational for new computer architectures, using modern, generally accepted software standards. It turned out that new developments in computer hardware, in particular the use of workstations such as the SGI Iris Indigo, enable the interactive use of numerical algorithms, thus adding a new dimension to the field of numerical mathematics.

Presently the possibilities of a longer-term project are investigated, in which input from new fields as symbolic manipulation and scientific visualisation will help in numerically assessing the quality of such models, as appear frequently in industrial settings. ■

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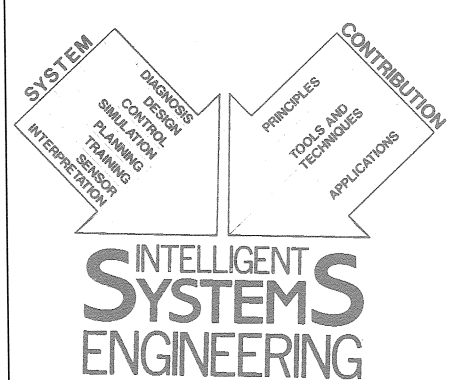
First International Conference on Intelligent Systems Engineering

Heriot-Watt University, UK, 19 – 21 August 1992

by Janet Efstathiou



In recent years we have seen the implementation of a range of applications of Artificial Intelligence to many domains of engineering. Together with the growth of applications, a corpus of underlying principles has emerged, leading to a more disciplined approach to the use of AI tools and techniques.

This conference is intended to bring together the underlying principles of AI and its engineering applications.

Invited Speakers will be Prof. Mike Brady (University of Oxford), Prof. Subrata Dasgupta (U Louisiana), Dr. Peter Struss (Siemens) and Prof. Lotfi Zadeh (UC Berkeley). The chairperson is Janet Efstathiou of the University of Oxford.

Applications sessions will include papers on a variety of AI applications in particular domains, such as transport or robotics.

Theory sessions will focus on the principles and tools to support engineering activities, such as design, fault diagnosis, sensor interpretation or control.

The conference is organised by The Computing and Control Division of the Institution of Electrical Engineers, in conjunction with the IEE/BCS journal "Intelligent Systems Engineering".

The working language of the Conference is English. The programme, registration form, and other information can be obtained from:

Conference Services, IEE, Savoy Place, London WC2R 0BL, UK
Intelligent Systems Engineering
ISE 92 ■

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SCAFI'92: Studies in Computer Algebra for Industry

Bath, UK, 30 Sep. – 1 Oct. 1992

by Michelle Heath

Computer algebra is relevant to many fields in Engineering and Science as the use of the computer enables calculations to be performed which would not otherwise be possible due to their size or complexity. SCAFI'92 is the first UK-based conference to be dedicated to examples of the industrial applications of computer algebra.

The aim of the conference is to demonstrate the usefulness and cost effectiveness of computer algebra in industry.The examples will be presented in a series of lectures by world-famous experts from several European countries and there will be demonstrations of computer algebra software.

The conference will be led by Professor James davenport and all the speakers are directly involved with the subject and its applications. Delegates will thus be able to see "hands-on" experience of various aspects of the technology and to discuss with the experts the relevance of computer algebra to their own industry.

The conference is funded in part by COMETT and ERCIM.

Location:

The conference will be held on the campus of the University of Bath, which is located just over a mile from the City Centre.

Deadlines:

31 August 1992 - Application deadline
7 September1992 - Cancellation and refund deadline.

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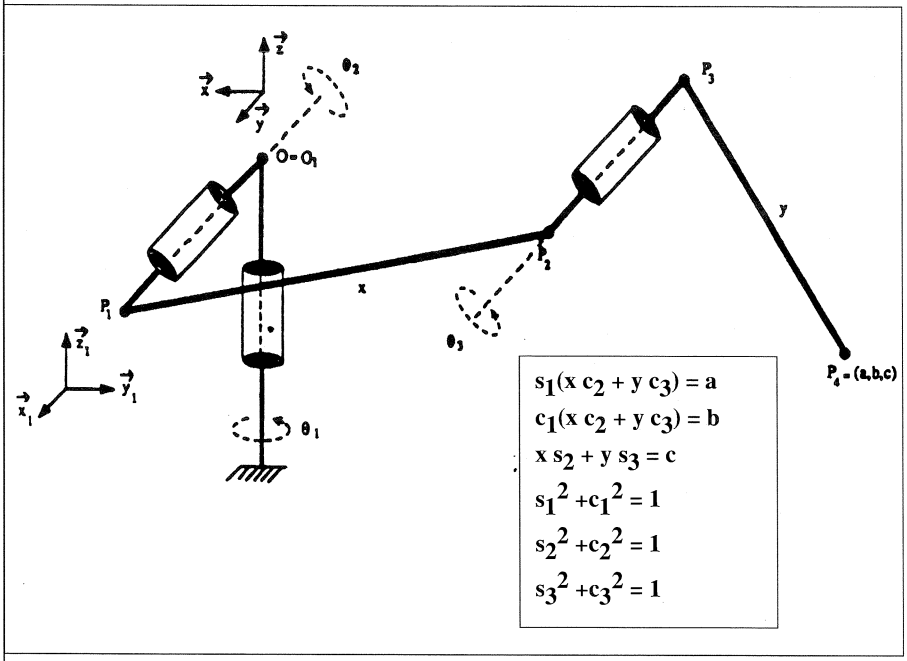

Computer algebra can be usefully applied to solve problems in robotics. The inverse geometric model of a robot manipulator involves finding the joint angles for a given place (position and orientation) of the manipulator tip. The problem can be stated as solving algebraically a system of polynomial equations with the joint angles as variables (s and c) and the place of the tip as parameters (x, y, a, b and c). Thus, for example, the tip's range can be easily and exactly computed. Such an approach has been applied to ROMIN (RObot Manipulator of Nuclear Intervention).

BECAUSE: Tools and Algorithms for Efficient Parallel Computational Continuum Mechanics

Sophia-Antipolis, France, 13-16 October 1992

by Loula Fezoui

The aim of the workshop, to be hosted by INRIA, is to gather scientists and engineers who are interested in the use of parallel computers for scientific and industrial applications.

Topics:

The emphasis will be on Continuum Mechanics, covering areas such as fluid mechanics, electromagnetic design, semiconductor device simulation, etc. Methods necessary for efficient parallel computation will be studied and compared. The hardware, languages, environment and software tools provided by some commercial machines will be considered along with new parallel numerical algorithms. The presentation and discussions at the Workshop will centre around the BECAUSE Benchmark Set (BBS). However, progress and new developments will be also reviewed.

Who should attend:

Anybody

- producing, using or interpreting benchmarks;
- studying/developing hardware/software tools for exploiting parallelism;
- studying/developing algorithms for exploiting parallel processors.

■

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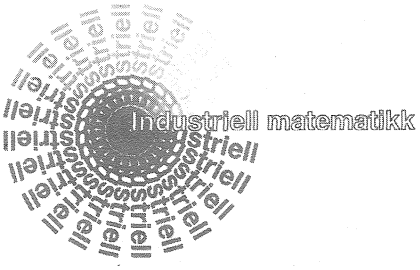

Industrial Mathematics Program: The first 10 years- Experiences and Challenges

Trondheim, Norway, 17 - 21 August 1992

by Anne Kajander

The conference and the following minisymposia focus on industrial applications of mathematics, numerics and statistics and university mathematics programs. The conference will be held on the Norwegian Institute for Mathematics (NTH) campus, in Trondheim.

Invited speakers are: Hendrik Martens (Norway): "The task ahead", Jacqueline Tjotta (Norway): "Some examples of mathematics as applied to acoustics", Gene Golub (USA): "Semi-iterative methods for solving linear systems", Hendrik van Tilborg (The Netherlands): "Discrete mathematics: why, when, and how", Georg Lindgren (Sweden): "Linear and nonlinear extremes in reliability", and Helmut Neunzert (Germany): "A complicated relationship: Experiences of a mathematician meeting industry".

A total of six minisymposia will be held on 20-21 August at the same location as the conference. The symposia lasts one day each, three running in parallel. The topics are:

- Mathematics in Engineering Education
- Numerical linear Algebra
- Statistical Methods in Image processing
- Applied Wavelet analysis
- Reliability Theory
- Supercomputing and Scientific Visualisation

Participation in the symposia is free. For additional information, please contact:

INDUMAT '92
Foundation for Continuing Education at NTH
N-7034 Trondheim, Norway
Tel: 47 7 59 52 46
Fax: 47 7 51 72 26

■

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email: kajander@imf.unit.no

INTERNATIONAL SUMMER SCHOOL ON CONSTRUCTIVE ALGORITHMICS

Hollum, The Netherlands, 21 September - 2 October 1992

by Erik Meijer

During the past few years the Dutch project, STOP, has worked on the development of theories supporting the systematic derivation of computer programs in a calculational style. The research has been conducted in close cooperation with PRG Oxford and the Technical University of Eindhoven. Within this framework the first Summerschool on Constructive Algorithmics was organized in 1989.

Calculational programming aims at the calculation of an efficient implementation from an obviously correct, but inefficient, or possibly not even executable specification. The research has resulted in many new insights into fundamental properties of algorithms such as compilers, dynamic programming and optimization problems, incremental algorithms, pattern matching, arithmetic circuits. Thanks to the introduction of convenient notations, calculation of programs has indeed become routine for these classes of problems. Category theory has proved to be a suitable mechanism for describing the underlying concepts of the different calculi in a succint and uniform way.

The aim of this second summer school is to present an overview of the theory that has been established over the last few years to a new generation of young researchers.

The lectures will cover a spectrum that includes the necessary algebraic and category theoretical background, a comprehensive survey of established theory, new developments and research results. An ample amount of time will be spent on exercises. This will enable the students to familiarise themselves thoroughly with the material and the techniques. The number of students will be strictly limited in order to allow an intensive interaction between students and lecturers.

The lectures will be given by active researchers in the field, including Roland Backhouse (Eindhoven University of Technology), Richard Bird (University of Oxford), John Hughes (Glasgow University), and Lambert Meertens (CWI, Amsterdam and University of Utrecht).

■

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CALL FOR PAPERS

TLCA: Typed Lambda Calculi and Applications

Utrecht, The Netherlands, 16 - 18 March 1993

by Marc Bezem

This international conference aims at providing a forum for the presentation and discussion of recent research in typed lambda calculi.

Topics:

- Proof theory of type systems
- Logic and type systems
- Typed lambda calculi as models of (higher order) computation
- Semantics of type systems
- Proof verification via type systems
- Type systems of programming languages
- Typed term rewriting systems

Deadline:

The deadline for submitting contributions to TLCA is 1 September 1992. The conference will be preceded by a symposium on March 15 to celebrate the 60th birthday of the Dutch logician Dirk van Dalen.

TLCA Secretariat:

Frans Snijders, CWI
P.O. Box 4079, 1009 AB Amsterdam,
The Netherlands
tel: +31 20 592 4171
fax: +31 20 592 4199
email: franss@cwi.nl

Please contact: Mark Bezem - Utrecht University
+31 30 535575
email: bezem@phil.ruu.nl

CALL FOR PAPERS

TAPSOFT'93: The Theory and Practice of Software Development

Orsay, France, 13 – 17 April 1993

by Marie-Claude Gaudel and Jean-Pierre Jouannaud

TAPSOFT'93 is the fourth International Joint Conference on the Theory and Practice of Software Development. Its predecessors were held in Berlin, Pisa, Barcelona and Brighton. Continuing with the tradition of high scientific quality of these meetings, TAPSOFT'93 will consist of three parts: a colloquium on trees in algebras and programming (CAAP), a colloquium on formal approaches of software engineering (FASE), and an advanced seminar.

Colloquium on Trees in Algebras and Programming (CAAP)

Originally this colloquium series was devoted to algebraic and combinatorial properties of trees and their role in various fields of computer science. The importance of the study of trees is now well established and many other discrete structures such as graphs play an increasingly important role. In keeping with CAAP's tradition, while also accounting for new trends, CAAP'93 will focus on the following topics:

- Logical, algebraic and combinatorial properties of discrete structures (strings, trees, graphs, etc), including the theory of formal languages considered in the broad sense as that of sets of discrete structures, the theory of rewriting systems over these objects, and the finite model theory.
- Application of discrete structures to computer science: syntax and semantics of programming languages, operational semantics, logic programming, constraint solving, algorithms and data structures, complexity of algorithms and implementational aspects, proof techniques for non-numerical algorithms, formal specifications, visualisation of trees and graphs, etc.

Colloquium on Formal Approaches of Software Engineering (FASE)

This colloquium aimsat being a forum where different formal approaches of the same problems – software specification, development and verification – will be presented, compared and discussed. Suggested topics include:

- Formal concepts for software development;
- Software development using formal methods;
- Formal approaches for concurrency, real-time systems, distributed systems;
- Formalisation of object oriented approaches;
- Provable correct software; verification methods;
- Merging of diverse formal approaches;
- Functional programming, logic programming, type systems;
- Tools and environments supporting formal approaches.

Advanced Seminar

Conferences and surveys will be given by: A. Arnold, P. Degano, N. Dershowitz, H. Ehrich, J. Guttag, C. Jones, G. Longo, B. Mahr, W. Thomas.

Contributions:

Original papers on the colloquia topics are sought. Prospective authors are invited to submit 5 copies of full papers (15 pages) to Jean-Pierre Jouannaud (CAAP) or Marie-Claude Gaudel (FASE) to the following address:

TAPSOFT'93
AFCET
156 Boulevard Pereire
75017 Paris (FRANCE)
Tel: +33 1 47 66 24 19
Fax: +33 1 42 67 93 12

Organisation:

The TAPSOFT'93 Organising Committee consists of: A. Finkel, M-C. Gaudel (general chair), J-P. Jouannaud, B. Rozoy and M-F. Kalogera (AFCET).

Deadlines:

15 Oct. 1992 – Submission deadline
1 Dec. 1992 – Notification of acceptance
31 Jan. 1993 – Final paper due

■

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email: tapsoft@lri.lri.fr

CALL FOR PAPERS

IFIP TC 5/WG 5.10 II Working Conference on Geometric Modelling in Computer Graphics

Genova, Italy, June 28 – July 2 1993

by Bianca Falcidieno

The Conference is intended to promote the exchange of research results in advanced modelling techniques related to Computer Graphics, pointing out the three main aspects of modelling: disciplines, roles and applications.

Suggested topics:

Disciplines of Modelling:
- Mathematical Modelling (topological modelling, geometric modelling, curves and surfaces, morphological modelling)
- Physical Modelling
- Procedural Modelling (constraint-based modelling, grammar-based modelling)
- Stochastic Modelling
- Fractals
- Visual Modelling

Roles of Modelling:
- Animation
- Display Algorithms
- Image Synthesis
- Rendering
- Textures
- Applications of Modelling

Education:
- User Interfaces
- Art Painting
- Geographic Information Systems
- Robotics
- Medicine
- CAD/CAM

Organisation:

The Conference is promoted by IFIP TC 5/WG 5.10, and organised in Genova (Italy) by I.M.A. (Institute for Applied Mathematics) of CNR.

Contributions:

Original unpublished papers of up to 5,000 words in length are invited on topics including, but not limited to, those listed above. Five copies of double spaced manuscripts in English should be sent to the address shown below by September 20, 1992. Accepted papers will appear in a Conference Proceedings volume published by Springer Verlag. For full instructions on the format of texts and any other information please contact:

Bianca Falcidieno (Programme chairperson)
Istituto per la Matematica Applicata - CNR.
Via L.B.Alberti, 4
16132 Genova (ITALY)

Deadlines:

20 Sep. 1992 – Deadline for full papers
30 Nov. 1992 – Notification of acceptance
30 Dec. 1992 – Camera-ready papers

■

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High-Performance Scientific Computing in Germany

by Johannes Linden

Research and development in the field of high-performance scientific computing require the interdisciplinary cooperation of computer science, mathematics and the application sciences. At a symposium held by the GMD, with the support of the Federal Research Ministry, on 2 and 3 December 1991 in Bonn, more than 100 leading German experts from the fields of higher education, research and industry came together to discuss, together and on a broad basis, both specialised and interdisciplinary aspects of high-performance scientific computing.

As a result in particular of the revolutionary developments in computer technology over the past few years, high-performance scientific computing has risen to the status of a key technology, unlocking entirely new possibilities for science, research and industrial product development. Computer applications which, owing to the enormous computing speeds they required, previously lay beyond the bounds of practical and economic feasibility on conventional mainframe computers, are now becoming a distinct possibility; in parts, indeed, they are already a reality.

Recognising the eminent strategic importance of high-performance scientific computing in the marketplace of the future, the USA has declared high-performance scientific computing a matter of top priority and allocated funding of more than a billion dollars to the field. In Europe, too, the working party around Carlo Rubbia, the Italian physicist and Nobel prize winner, recommended in its report of spring 1991 that the EC Commission should give vigorous support to high-performance scientific computing.

In order to remain internationally competitive, science and development in Germany will also have to coordinate their

efforts at both a thematic and organisational level. At the symposium, the major users of high-performance computers had the opportunity to voice their needs as regards hardware, software and algorithm development. A report due to be completed shortly will take stock of the current situation of high-performance computing in Germany, and detail the recommendations, organisational and structural measures and consequences for German research policy which it implies. ■

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Podium discussion concluding the symposium on High-Performance Scientific Computing, with, from left to right: Falk D. Kübler (Parsytec GmbH), Prof. Dr. Wolfgang Paul (University of Saarbrücken), Prof. Dr. Willi Jäger (University of Heidelberg), Assistant Secretary Dr. Klaus Rupf (Federal Research Ministry), Prof. Dr. Dennis Tsichritzis (GMD), Prof. Dr. Ulrich Trottenberg (GMD), Prof. Dr. Deuflhard (Konrad-Zuse-Zentrum, Berlin). (Photo: Münch, GMD)

IN BRIEF

CWI – Tom Koornwinder, researcher at CWI, has been appointed Professor in Analysis at the University of Amsterdam from 1 May 1992. He will remain affiliated with CWI for some time. Koornwinder's present research interest is mainly in the field of special functions and group theory. ■

GMD – Prof. Dr. Stefan Jähnichen, head of the GMD Research Institute for Program Structures in Karlsruhe, has accepted the post of Professor of Software Technology at Berlin Technical University. Jähnichen has also been made head of the Berlin GMD Institute for Computer and Software Technology, alongside the existing heads, Prof. Dr. Wolfgang K. Giloi and Dr. Peter Behr. ■

CNR – The agreement for cooperation between the Italian Space Agency (ASI) and CNUCE-CNR is being renewed to cover the period 1992-1994 inclusive. CNUCE will provide ASI with support for mission design and analysis and flight dynamics. The major projects in which CNUCE will be involved are IRIS/LAGEOS-II, in cooperation with NASA, and X-SAR, in cooperation with the German DLR and the Jet Propulsion Labporatory (JPL). ■

INRIA – A cooperation agreement between the Royal Institute of Technology (Sweden) and INRIA was signed in January this year. The themes include: Optimisation, Systems and Control, Parallel Computer Architecture Computational Fluid Dynamics, Neural Networks, Computer Vision and Speech Recognition. ■

CWI – Some years ago the Netherlands Organization for Scientific Research NWO started its **Priority Programme** giving substantial support to selected research areas. Recently the subject of Non-linear Systems was chosen for this form of support. The programme coordinator is Odo Diekmann, leader of CWI's research programme on Mathematical Modeling and Analysis and professor of Bio-mathematics at the University of Leiden. ■

GMD – Herwig Heckl, head of the GMD's major research project "Integrated Circuits Design" (E.I.S), retired from the GMD within the framework of a scientific symposium on "Computer-aided Design of Chips and Systems - A Task of Infrastructure and Research". **Prof. Dr. Raul Camposano** was simultaneously appointed in his place. As part of the restructuring of the GMD, the E.I.S. major project has now been reorganised into the Institute for Systems Design Technology. ■

CNR – Antonio Blasco Bonito, CNUCE-CNR, has been nominated Vice-President of RIPE, "Réseaux IP Européens". The objective of RIPE is to ensure the necessary administrative and technical coordination to allow the operation and expansion of a pan-European IP network. RIPE acts as a forum for the exchange of technical information and the creation of expertise on IP networking and establishes agreement on common network management practices and the operational management of the interconnected networks. ■

GMD – Prof. Dr. Wolfgang K. Giloi, Professor of Technical Computer Science at Berlin Technical University and institute head of the GMD Institute for Computer and Software Technology, has been named an IEEE Fellow of the Institute of Electrical and Electronics Engineers (IEEE). Prof. Giloi was awarded this distinction "for his services as an engineer and his leading technical role in the development of computer systems". ■

European Research Consortium for Informatics and Mathematics

ERCIM

The European Research Consortium for Informatics and Mathematics (ERCIM) is an organisation dedicated to the advancement of European research and development, in the areas of information technology and applied mathematics. Through the definition of common scientific goals and strategies, its national member institutions aim to foster collaborative work within the European research community and to increase co-operation with European industry. To further these objectives, ERCIM organises joint technical Workshops and Advanced Courses, sponsors a Fellowship Programme for talented young researchers, undertakes joint strategic projects, and publishes a newsletter.

ERCIM News is the in-house magazine of ERCIM. Published quarterly, the newsletter reports on joint actions of the ERCIM partners, and aims to reflect the contribution made by ERCIM to the European Community in Information Technology. Through short articles and news items, it provides a forum for the exchange of information between the institutes and also with the wider scientific community.

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