

EDITORIAL



Prof. John Mylopoulos, from the Department of Computer Science, University of Toronto, underscores the importance of Software reuse in general, but also the important role ERCIM member organizations can play in any technological advance on the topic.

SPECIAL :

Activities in Software Reuse	7
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Next Issue:

Large-scale Scientific Computing

The high cost and poor quality of software are often cited as the most critical bottlenecks in the development and evolution of information technology. Software reuse constitutes a relatively recent research theme (some call it a slogan!) which proposes to tackle these problems head-on by offering a combination of concepts, methods and tools to support the process of reusing existing software components. Not surprising, software reuse has grabbed center-stage in international software engineering research, promising to deliver the productivity increase that will eliminate, or at least alleviate, the software crisis.

Unfortunately the path that will make software reuse a reality is not as clearly defined as its promised results. Program libraries, properly populated, are certainly a step in the right direction and they are already practiced for well-understood domains such as numerical software. So is organizational support for and encouragement of reuse, aided by rewards for code- or experience-sharing among software development teams. Object-oriented computing constitutes yet another touted path to the reuse silver bullet. Better understanding of the process of software reuse, supported by appropriate tools is another. So is research that advocates linking software reuse to design reuse in general (as in hardware or architectural design), or calls for the development of "intelligent" AI-based methods such as case-based reasoning and case-based knowledge organization to address it.

Despite this wealth of diverse approaches to reuse, some themes are common. Fundamental among them is the thesis that reuse concerns more than software code. Designs, requirements specifications, development processes are also reusable and can contribute as much to the legendary productivity increase as the reuse of existing programs. Indeed, software reuse concerns *all aspects* of the software development experience. Consequently, one can characterize the degree of reuse in terms of a channel of communication between original developer(s) and the reuser(s). The broader and better defined the channel, the greater the potential for reuse, and therefore for productivity improvements. For program libraries, for example, the channel is well defined but narrow, since all development experience other than coding is missing. For experience-sharing meetings between original developer and re-user the channel is broad but ill-defined as it relies on human memory and organizational practice. A major thrust of research on reuse is the development of methods and tools which broaden and sharpen this channel, by facilitating the recording of the software development experience in all its breadth and richness and by assisting in its selection and adaption. A key component of this thrust is software repository technology. Another is the toolset that supports particular phases of reuse from exploration of a repository to selection of relevant software components and adaption. A third, probably most important, component is the study of the software reuse *process* and the definition of reuse methodologies that work.

The dedication of this issue to software reuse underscores the importance of the topic in general, but also the important role ERCIM member organizations can play in any technological advance on the topic. I look forward to reading the issue cover-to-cover!

John Mylopoulos

Next ERCIM Workshops

The ERCIM fall workshops, taking place in November later this year, will be hosted by INRIA and located at the different INRIA sites throughout France.

The four workshops are:

- **Multimodal Human-Computer Interaction**

Nancy, 2-4 November 1993

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- **Development and Transformation of Programs**

Nancy, France, 2-4 November 1993

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- **Parallelism and Non-determinism in Active Database Application**

Rocquencourt, 2-4 November 1993

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- **Stochastic Numerical Methods for Solving PDE's, and Applications**

Sophia-Antipolis,

8-9 November 1993

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ERCIM Workshops

ERCIM Workshops in Norway

by Truls Gjestland

The ERCIM 1993 Spring Workshops was hosted by SINTEF DELAB 26-28 May. The meetings started with half a day visit to the SINTEF home base at the Norwegian Institute of Technology in Trondheim.

In his opening address, the ERCIM President Cor Baayen, amused everyone with a very personal interpretation of the interrelations between the Norwegian vikings and the rest of Europe. After a presentation of SINTEF and the Norwegian Institute of Technology, the participants were taken to the small mountain village of Røros for the individual workshops.

All together 120 people participated in the different workshops and meetings. Three workshops on the following themes were running in parallel:

- Interactive Modelling, Simulation and Visualization in Large-Scale Scientific Computing
- Modelling and Simulation of Industrial Processes
- Storage and Retrieval of Multimedia Information

In addition the Executive Committee, the Board of Directors and the Editorial Board had their meetings. At the Executive Committee Meeting 28 May a consortium of Spanish universities, AEDIMA, became the 10th member to join ERCIM.

According to the recommendations of the Executive Committee the workshops were organized with an emphasis on discussions in smaller working groups, and the presentation of ongoing activities were made in poster sessions rather than the usual conference format.

Modelling and Simulation of Industrial Process Systems

This workshop focused on the modelling of industrial process systems, including both discrete manufacturing and continuous process systems. There is an increased awareness of the fact that although different types of models have traditionally been used by different engineering disciplines, new possibilities open up if the different types of models may be combined. The reason is that a given type of model will only reflect a subset of the characteristic properties of the system. But many applications may require that several different types of characteristic properties are taken into account. One path for improving the models used for industrial applications involves understanding which properties are reflected by the different types of models, and how the models may be combined.

The workshop included presentation covering everything from models used for software engineering purposes, to models used for shop-floor control and models describing the continuous dynamic behaviour of chemical plants. The workshop demonstrated that the ERCIM institutes have very diverse activities in the area of modelling of process and production systems. To a large extent, the activities are complimentary and this implies that there are excellent opportunities for future cooperation.

The workshop concluded with a desire to continue the discussions and improve the relationships among the ERCIM institutes in this area. As a first step, an e-mail list for discussion of topics relating to modelling of process and production systems has been established. The address to this list is

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To be included on this e-mail list, please send a request to

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Storage and Retrieval of Multimedia Information

The workshop on Storage and Retrieval of Multimedia Information was organized as a combination of plenary sessions with a tutorial and 9 selected presentations, and discussions in three smaller working groups. More than 40 people participated actively in the workshop. The presentations covered a wide area of multimedia research; from user participation in developing multimedia user interfaces to techniques for storing data on optical discs. This introductory papers were very valuable for the discussions in the three smaller working groups.

The topics for the groups were:

- Modelling and retrieval of multimedia information;
- Synchronization and architectural issues;
- User interfaces for multimedia retrieval.

Each group were asked to discuss the state-of-the-art in the selected area, identify topics of special importance that need further research, and to give recommendations for further cooperation in the ERCIM community, preferably to propose possible project ideas.

The Modelling and Retrieval subgroup discussed a number of issues, and stated that most of them also are valid for non-multimedia applications. However, multimedia gives new requirements in areas like non-textual querying languages, content descriptions, temporal aspects, media translation, and synchronization. Possible common projects were discussed. The most concrete idea is to make a demonstrator to be used by the Information officers in ERCIM to produce and exchange newsletters, proposals and to assist in multimedia conferences and discussions.

The subgroup discussing Synchronization and Architectures concluded that it is too early to start cooperation projects within ERCIM. E-mail discussions will continue in order to locate the main problems in the area. The most important issue is to explore how to build common frameworks and models.

The User Interface subgroup stressed that this is an area that needs a multi-disciplinary approach, and that a F&U project-team needs skilled people in disciplines like psychology, perception, film, dramaturgy, pedagogy, etcetera in addition to informatics. When developing an application the usage of video, sound and animation should be well motivated and directed by the users' needs.

The group identified several areas for further R&D:

- Automatic generation of multimedia user interfaces;
- Development of new authoring tools;
- Evaluation of metaphors.

Indexing of unstructured/temporal data. The group did also point out the need for a development of a special curriculum for the education of multimedia architects.

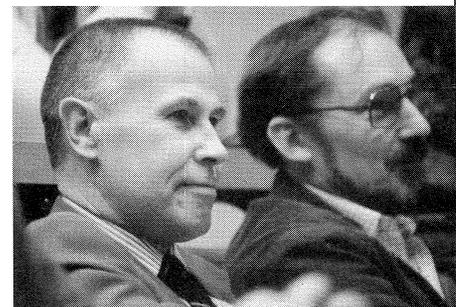
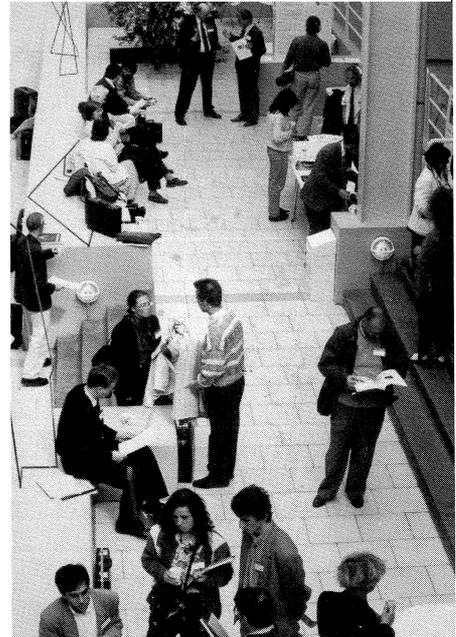
All three groups reported the intention of further informal discussions by e-mail, and that they found the building of personal networks extremely valuable. Until the multimedia field gets more mature it was proposed to keep just one multimedia interest group in ERCIM, without further subdivisions.

A majority of the participants seemed to agree that the ERCIM workshop should continue to be an informal meeting-place for exchange of viewpoints and a forum for discussing new ideas and cooperation, and not "just another conference".

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Interactive Modelling, Simulation and Visualization in Large-scale Scientific Computing

The main goal of the workshop was to bring together scientists and engineers to exchange experience and ideas about ex-



isting and future technology and techniques which are believed to be important in the context of interactive large-scale simulation of processes and phenomena in science and engineering.

The main issues are:

- high-performance numerical algorithms for advanced computer architectures;
- environments and tools for interactive large-scale numerical simulation;
- scientific visualization methodologies.

The workshop assembled 23 participants from all 10 ERCIM institutes, as well as two invited speakers from USA and England.

The first day, in the afternoon, Kevin Fox from Cray Research Inc. (UK) gave an introductory speech titled "A Perspective on Interactive Large Scale Simulation in Science and Engineering - Limitations and Possibilities". The rest of the day was allocated to posters, which added to 12 presentations from 6 different member institutions. In the morning of the following day, Prof. Suhrit Dey from Eastern Illinois University gave an invited speech titled "A Massively Parallel Algorithm for Large-scale Non-linear Computations with Application to Non-linear Parabolic PDE's". The rest of the workshop was allocated for discussions in two groups (about half of the participants in each group). However, at the end of each day, a plenum discussion was conducted, with the objectives of exchanging information between the groups.

In the following, conclusions of the working group are included.

- The algorithms group:

The group attempted to determine common interests, research issues and directions of future work. The discussion led to the following conclusions and recommendations:

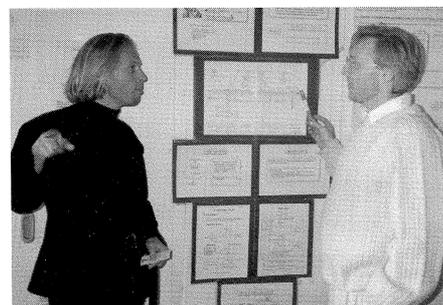
Emphasis should be placed on parallel solution of differential equations and associated numerical problems, in particular systems of algebraic equations (linear and nonlinear). Applications exam-

ples should include problems of physics, engineering, elasticity, CFD, chemistry, environmental problems, weather prediction problems and other similar applications. Model problems involving the solution of two or three dimensional PDE's should be considered as there is a lot to be learned from solving such problems.

Two directions are considered important for these applications: the development of new parallel algorithms, and the parallelization of existing algorithms.

Research and development in both directions should examine the issues of scalability and portability and should emphasize techniques involving domain decomposition, partition and allocation, grid partitioning and data transposition. Local refinement techniques and adaptivity are particular new and important fields to be examined and developed in parallel computing.

In order to study the behaviour and performance of parallel algorithms it is necessary to improve on paradigms or models of parallel computation and combine



the theoretical study with extensive experimentation.

Powerful techniques in interactive visualization are expected to play a key role in several aspects of the development, the study and the efficiency of parallel algorithms. Examples of interest include interactive visualization for the geometric aspects of the computation (e.g. grid generation and mesh adaptation), the postprocessing and presentation of results, and the visualization of the behaviour of algorithms based on monitoring tools and measurements.

- The tools & visualization group

This group also attempted to determine research issues and directions of future work. The discussion led to the following:

A number of common visualization techniques are being demanded:

1. Intelligent probing: current probing techniques are not satisfactory as they can not provide sufficient information of the ongoing simulation. This is due to the decoupling of the visualization data types with the application data types. New techniques need to be provided which allow:
 - information extraction: high-level information to be extracted from the ongoing simulation and/or the resulting simulation database.
 - the "physical" meaning of underlying phenomena to be visualized.
2. History matching: new techniques must be found which allow matching of visualization on perturbed simulation parameters.
3. Computational steering: current visualization techniques are based on post-processing results of a simulation. If direct interaction with an ongoing simulation is to be achieved, then novel techniques for:
 - navigation through spatial domains
 - monitoring of various simulation processes need to be studied.

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ERCIM Electronic Mailing-lists

Two electronic mailing-lists have just been set up at ERCIM's central office located at INRIA.

1. Ercim.activities@inria.fr

This is a public unmoderated mailing-list aiming at exchanging information on activities organised by ERCIM. Items would include activities such as workshops, advanced courses, symposia, conferences which would be of interest to the ERCIM members. If enough interest is shown, specialised sub-lists will be set up. If sufficient number of people subscribe, this list might be replaced by a public internet newsgroup in the future.

If you want to be added to this mailing-list, just send a message containing the sentence "I want to subscribe to Ercim.activities" and your e-mail address (internet or X.400) to:

Ercim.requests@inria.fr

Please do NOT send subscription requests directly to Ercim.activities.

2. Ercim.fellows@inria.fr

Scientists who would like to receive information about the ERCIM Fellowship Programme can now send their e-mail messages directly to this address. Messages will be read by the ERCIM staff in charge on managing the fellowship programme.

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ERCIM Symposia

ERCIM Technology Transfer Symposium at RAL

Abington, UK,
10 -12 November 1993

ERCIM is organising a series of Technology Transfer Symposia and the first of these - "Affordable Parallel Processing for Industry and Commerce" - is being hosted and organised by RAL under the direction of a Steering Committee drawn from the ERCIM member Institutes. Besides introducing European SMEs to Parallel Processing, the Symposium is seen as a foundation on which ERCIM can build a reputation for expertise and introduce itself to, and form relationships with, European SMEs.

The programme for this event will cover such topics as hardware issues, software issues, I/O intensive applications, real-time systems and fault tolerant systems. These issues will be addressed by acknowledged authorities in these domains, mostly staff from ERCIM institutes, underlining ERCIM's expertise in this area. The programme will include a series of industrial case studies, several of which were developed with ERCIM partner involvement, to highlight not only the diversity of applications already being addressed, but also the commercial advantages of moving to Parallel Processing.

The programme will go on to consider trends, both current and in the future, in the further development of this technology and will include a visit to RAL where various Parallel Processing systems ranging from simple transputer systems to a Cray YMP will be seen in use.

This Symposium is NOT generally open to ERCIM staff; if however you would like further information or know of an

SME that would be interested in attending, please contact the address below or your local Symposium Steering Committee member.

Committee members : K Bratbergsengen (SINTEF), J Delgado (INESC), W Jalby (INRIA), E Hagersten (SICS), D Laforenza (CNR), C Nikolaou (FORTH), H te Riele (CWI), B Steckel (GMD), M Valero (AEDIMA).

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ERCIM Fellows

The 1993-1994 ERCIM Fellowship Programme

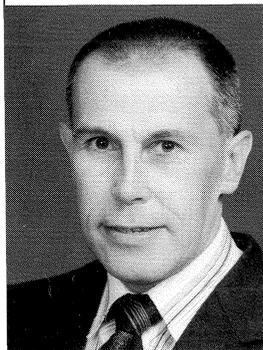
by Annick Theis-Viémont

After publication of the call for applicants, 100 applications from the international scientific community were received at the ERCIM Bureau for the 9 possible positions to be filled. The Selection Meeting was held in April and retained the 9 best applicants. At the present stage, allocations are not completely set. The names of the fellows, their field of research, the host institutions and the dates of the stays will be published in the next issue of this newsletter.

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High Performance Computing and Networking



Prof. Bob Hopgood, RAL, Chairman of the ERCIM Executive Committee. (Photo: RAL)

by Bob Hopgood

The Commission set up a Working Party chaired by Professor Rubbia to consider what should be done in Europe in the area of High Performance Computing (HPC). The Working Party was mainly a reaction to the USA's Federal Programme High Performance Computing and the National Research and Education Network (HPCC). The US project's aim was to maintain the USA's position in high performance computing.

The Report of the High Performance Computing and Networking Advisory Committee (often called the Rubbia report) was published in October 1992. It proposed a large programme aimed at establishing a European industrial and scientific lead in the combined area of High Performance Computing and Networking.

As a result of the Rubbia Report, in the working paper on the Fourth Framework Programme (1994-1998), the Commission has proposed a core thematic area entitled High Performance Computing and Networking, the aim of which is to enable a broad category of users to benefit from the new prospects offered by high performance computing and networking.

The areas addressed by the Rubbia Report are sufficiently important that an

ERCIM view of the conclusions was important. Since October, experts from the ERCIM institutes have worked to produce their own view of the Working Party's conclusions and these have been published as an ERCIM Report entitled ERCIM Comments on High Performance Computing and Networking.

ERCIM supported the main conclusions of the Rubbia Report, namely:

1. The strategic importance of parallel computing.
2. The strength of European research in parallel computing.
3. The poor record Europe has of turning research results into products.
4. The need for a high speed networking infrastructure.

Having said that, ERCIM had considerable misgivings concerning the proposed programme based on these conclusions. In particular:

1. The intimate linking of High Performance Computing and High Performance Networking was not felt to be justified. High performance communication is needed by a whole range of applications and High Performance Computing is not necessarily the most demanding or the most important.
2. The Rubbia Report break downs applications into simulation and design, information management, and embedded systems. The breakdown seems artificial. The first two are intimately related while the third is clearly inappropriate for an HPCN project.
3. The management structure proposed was effectively a carry-on from the existing structures used by ESPRIT. In its Strategic Research, a Major Focus for the Fourth Framework Pro-

gramme, ERCIM has already indicated a number of problems with the existing structures. There seems no good justification for carrying these forward to the next generation of projects. For example, integration of end-users into projects and the unavailability of assessments from projects outside the consortium were two areas of concern.

Rather than just being negative, ERCIM believes an alternative strategy is possible which will achieve the aims of the Rubbia report more effectively than the proposed programme. The main points of the ERCIM proposal are:

1. High Performance Networking should be separated from HPC. It should be independent and available to all new initiatives and based on a broader base of applications.
2. An HPC initiative should concentrate solely on those activities of benefit to Europe and its industry that require centralised high performance computing, rather than attempting to cover the whole area of parallel processing.
3. A separate initiative aimed at the use of Affordable Parallel Processing should be started. It should provide a generic environment aimed at an industrial sector of prime importance to Europe. This would be preferable to attempting to cover the whole area of parallel processing in a single initiative.

Copies of the ERCIM Report can be obtained by writing to the ERCIM Office at Rocquencourt.

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Software Reuse: Activities within the ERCIM Institutes



Dr. Hans Voss, GMD
(Photo: Münch, GMD)

by Hans Voss

Most home owners could not afford to buy a house designed and built according to their dreams. They feel content with one that shares its main characteristics with the next-door houses, and possibly allows for individual variations that could be realized with minor effort and cost. Companies who have problems to be solved by software are not interested in very individual solutions either. They want to have their problems solved quickly, according to appropriate standards of quality, and they want the solutions to be cheap! Better exploitation of reuse must certainly become a prime factor if the large backlog of problems that most companies complain about is ever to be reduced. Although not new, the idea of investigating and exploiting reuse has become very popular in recent years. The idea of reusing chunks of software assets is also an essential ingredient of related fields such as enterprise modeling, enterprise integration, or domain analysis. It is important to note that reuse is not only an issue to be solved at the technical level. Its success will heavily depend on appropriately taking into account social, organizational, managerial, psychological and legal factors as well.

Some twenty papers presented at the Workshop on "Methods and Tools for Software Reuse" in October 92 showed that there is already considerable interest in this topic among the ERCIM members. Most contributions to this Newsletter were presented at the workshop in greater detail. As evident from the contributions, reuse is a very broad issue necessarily covering many topics.

The emergence of object-oriented (OO) methodologies is a major reason for the growing popularity of the field. Most contributions refer to specialization hierarchies and inheritance as an essential ingredient for exploiting reuse. Therefore, object-orientation was not a valuable criterion for surveying the project summaries of this issue. We will instead focus on other recurring issues, namely reverse engineering, conceptual modelling and life-cycle support, repositories, and work in knowledge engineering.

If the advent of reuse is not meant to develop the whole existing software base anew then we must find ways of integrating the vast body of existing software assets (or at least a substantial part of it) into future developments. Reverse engineering, e.g., writing OO wrappers around existing modules is one possible way to achieve this. Three projects at CNUCE-CNR all start with analyzing existing source code: programs are analyzed and transformed so that they can be integrated and used by a CASE tool; a hypertext tool for reverse engineering has been built that takes into account source code but also informal documents; an effort is made towards object-oriented Re-Engineering where non-OO source code is analyzed and transformed into OO code. At GMD, tools are provided that support maintenance personnel in transforming existing software into object-oriented form. Objects discovered in the transformation process are stored for re-

vision and further use. RAL applies the Vienna Development Method for reverse engineering. Starting with operational definitions at a low level of abstraction, more abstract, implicit definitions describing the function of a program are iteratively deduced.

Extremely important for the overall success is the adaptation of life-cycle models to support reuse at all phases and for all of its products. According to well-known results about the high percentage of work spent in pre-implementation phases, reuse of specifications and process-knowledge is particularly rewarding. The idea of a project at INRIA is to record development steps as application of operators on states, and thus to support reuse of pieces of the product as well as strategies. INESC considers a formal and declarative framework for object-oriented, logic-based conceptual modelling that includes descriptions of behavioural properties of objects like safety and liveness conditions of respective events.

The integrated usage and incremental development of component libraries - so-called repositories - must be considered essential activities of reuse-oriented life-cycle models. In the Esprit-project REBOOT a software engineering environment with integrated DBMS to create and reuse OO software components is developed. A first prototype, including a repository populated with general-purpose as well as domain-specific components, has been completed. ICS-FORTH reports on the development of a software information base that incorporates a faceted classification scheme implemented as a system of interleaved isA-hierarchies. Several schemes may be used concurrently, e.g., for assets related to code, analysis, and design components. INESC is also developing repositories with software components being formally defined by their internal states, associated basic

Software Classification and Static Analysis in the Software Information Base

by Panos Constantopoulos and Martin Doerr

Finding a suitable component is the initial step in the software reuse process. To this end, a directory to a collection of reusable components is necessary. The Software Information Base (SIB) is such a directory developed at ICS-FORTH, tested with libraries of more than 5,000 components, which has already been presented in the ERCIM News No.10 .

The SIB establishes a semantic network of descriptions pertinent to the reuse at all stages of the software life cycle. It supports uniform treatment of data and schema, unbounded levels of instantiation, multiple inheritance, runtime introduction of domain-specific concepts, search by multiple and recursive conditions, navigational search, and offers a customizable user interface. It especially attends to the needs for disciplined representation of an evolving body of software engineering knowledge, by use of abstract and implicit properties, accessibility of schema information and visualization of complex structures.

The original SIB software representation model has recently been enhanced by incorporating a faceted classification scheme. Faceted classification has been proposed for software documentation (Prieto-Diaz, REBOOT project) to overcome the failure of ad hoc keyword systems and tree-like classifications. By mapping a faceted classification scheme on the SIB model of representation, the relation of classification terms is determined in a language-independent man-

ner, the user's understanding of the indexing system and the terminology is improved, and the classification effort is streamlined and minimized. To achieve the latter, static analysis data, generated by code structure parsers, are employed to provide the correlation of the facet terms for each component.

The faceted classification scheme is implemented as a system of interleaved isA hierarchies. Facets are metaclasses whose instances are the corresponding terms, regarded as classes of entities. The terms of each facet, which can have synonyms, are organized in an isA hierarchy according to the specificity of their meaning. The sharing of properties between terms is expressed by common super-terms, thus employing multiple inheritance. Homonyms are distinguished by suitable prefixes. By virtue of inheritance, the enumeration (often inconsistent) of more generic keywords in classifying a component is avoided. The structure of the term (concept) hierarchies is robust against translation between natural languages. It also determines a conceptual distance between terms, suitable for computing term relaxation in query processing.

The facets, reflecting the functional role of components in a process, are Abstraction, Operation, OperatesOn and Dependencies (like in REBOOT). Facet terms are applied to static analysis data. Abstraction terms are nouns representing "active" object types; Operation terms are verbal types representing specific activities associated with methods; OperatesOn terms are nouns representing object types acted on, including Abstractions, basic data types and peripheral devices; and Dependencies represent environmental conditions.

Under this classification scheme, the unit for retrieval is the object type (e.g. C++ class). An unlimited number of concurrent classification schemes is realizable. The one described is related to code level reuse. Classifications corresponding to the requirements and design levels of reuse, also supported by the SIB, are currently investigated.

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operations, and their functional decomposition.

Identification and utilization of generic problem-solving methods has a long tradition in Artificial Intelligence research. The general idea is to separate domain-specific, application-independent knowledge from knowledge about how to use it in specific kinds of applications, like diagnosis or design, or in different instances of the same kind of application. With the knowledge engineering environment MoMo, GMD emphasizes a development process oriented towards reuse and prototyping. The general idea is to drive knowledge acquisition by the contents of generic problem-solving methods that are available in libraries. The method has also been used for reverse engineering a set of tools for model-based diagnosis. RAL developed a platform comprising generic knowledge about managing water supply and distribution systems. When applying the framework to a particular site, they realized savings in all phases of the development process.

Investigating methods, applicability, pitfalls, and the potential of reuse is a predestined topic for computer science institutes that are supposed to bridge the gap between research results and industrially applicable, systemic solutions. Due to its complex and interdisciplinary nature, reuse can only be successful in the long run if results from data-, software-, and knowledge engineering are exploited in an integrated way. The Crete workshop and the contributions to this Newsletter have already shown that ERCIM members should have a great interest in further communication and cooperation. A follow-up workshop in the not too distant future would be a next, reasonable step.

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Redocumentation, Reverse Engineering and Reuse at CNUCE-CNR

by Oreste Signore
and Mario Loffredo

Software reusability activities are based on processes of analysis and abstraction. The aim is to implement more extendible and maintainable software systems and rescue the existing software patrimony. Work in this area at CNUCE has followed three different directions: integration with a CASE tool; re-documentation in a hypertext environment; re-engineering towards an object-oriented environment. Each of these approaches starts with an analysis of the source code.

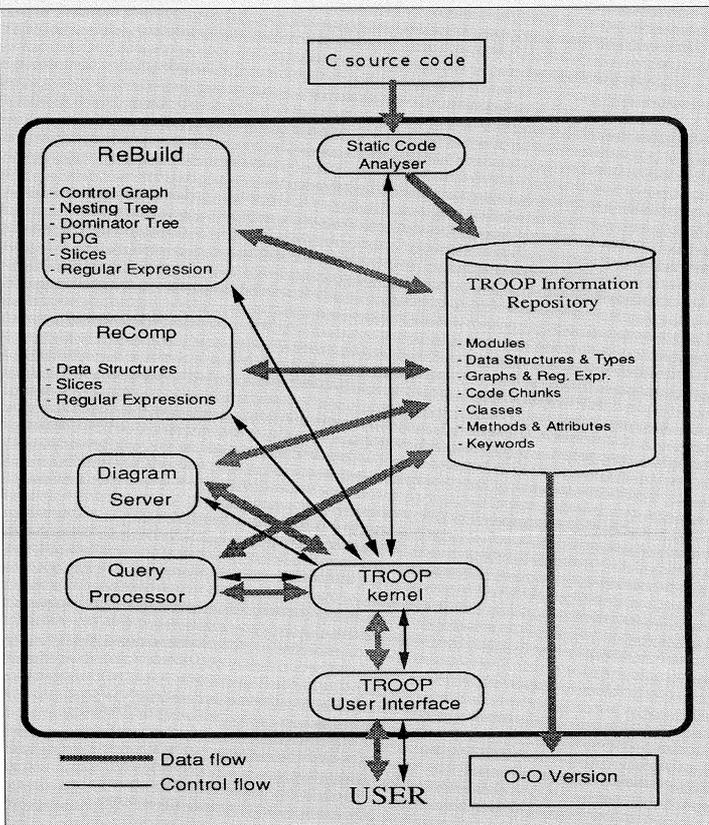
In the first activity, we have developed a prototype tool, Charon, which implements an automatic reconstruction of software documentation and code re-engineering. Charon's re-engineering cycle has a C/SQL program as source and a different version of the same program, written in COBOL/CICS/DB2, as target. The reverse engineering step is performed by the static C code analyser C-TOOL; the

forward one is executed by the ADW COBOL code automatic generator. The C-TOOL was developed by CRIAI (Consorzio Campano di Ricerca per l'Informatica e l'Automazione Industriale) and has been modified in order to intercept SQL statements. Applying this process, the user can extract information pertinent to higher level design phases, concerning either the data (Entity-Relationship Diagram, Entity Type Description, SQL Action Diagram, etc.) or the processes (Structure Chart, Module Action Diagram). The subsequent forward engineering step has all the advantages claimed by the CASE tools.

As the reconstruction of software documentation and the capture of its semantics is essentially an associative task, and therefore requires human intervention, we have designed HYRE (HYpertext for Reverse Engineering). The user can use this tool to inspect and annotate the code, and extract modules or extract information such as the entities, relations, at-

tributes, data types, etc. Informal data, like user manuals, maintenance requests, generic documents, error reports and so on, can also be considered. The basic rationale is that the user should operate, as far as possible, in his customary fashion. The tool is characterised by the emphasis put on human intervention and the availability of a suitable repository where collected information can be stored for subsequent analysis and integration into more conventional environments. However, at the present stage, this tool is cumbersome to use: the user is obliged to perform a set of trivial operations manually that could easily be automated. Some enhancements are currently under investigation, but we intend to use automatic analysis tools only for the most trivial activities or to formulate hypotheses that must be evaluated by the user.

The growing popularity of object-oriented methodologies seems to offer a completely new area of research for software engineering; they promise software systems that are more easily maintainable and better documented than systems developed using more traditional methodologies. For this reason, we have identified Object-Oriented Re-Engineering as an important line of research, and we are currently developing a tool that addresses the task of re-engineering programs towards an object-oriented environment. This tool is called TROOP (Tool for Re-engineering towards Object-Oriented Paradigm). By analysing the code, we first obtain a list of *candidate objects* and a set of *candidate methods* that become real objects and methods after human intervention and validation. The second step is program slicing, performed by constructing a Program Dependence Graph. In the third step, we try to identify *similarities* between portions of code, looking for the equal regular expressions representing the code, for equal slices and equivalent semantics. Finally, we identify the objects, methods and inheritance hierarchies. In this phase, human intervention is required to validate the choices made. The informal documentation may be taken into account. The general architecture of TROOP is shown in the figure which clearly identifies the importance of a central repository where we can store the knowledge deduced from the analy-



The general architecture of TROOP identifying the importance of a central repository where the knowledge deduced from the analysis of the existing software and other information sources can be stored.

sis of the existing software and other information sources.

A Static Code Analyser is currently under development in the Software Engineering and Applications Laboratory at CNUCE-CNR. Diagram Server, a tool developed by G. Di Battista at Rome University, is used to display graphs described formally, and permits their interactive manipulation by the user. The representations will be generated by the ReBuild (Representation Builder) module, while the ReComp (Representation Comparator) module will analyse the similarities between them. As far as the Information Retrieval aspect is concerned, we will adopt a document vector space model, where each *document* is identified by a set of weighted keywords, selected from a classification scheme. The classification scheme will be displayed to the user, who can navigate through it choosing the correct terms. The user interface will be developed in a windows environment and will offer some hypertext capabilities. ■

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Reuse-Oriented Knowledge Engineering

by Hans Voss
and Thomas Hemmann

The identification and utilization of generic problem-solving methods (PSMs) is a central concern in Artificial Intelligence. Expert system research brought forth a bunch of generic methods, several of which have been captured in so-called shells. Moreover, the last decade is driven by the insight that the development of knowledge-based systems must rely on well-defined life-cycle models. In particular, PSMs and domain knowledge should be specified at a conceptual level independent of

particular implementations. In this view, knowledge representation belongs to the design or implementation phase.

Many conceptual models of PSMs have already been defined. Our dream is to let project teams create applications by composing components retrieved from libraries rather than building them from scratch. Libraries may contain conceptual models for PSMs, domain ontologies, particular domain descriptions, design models relating PSMs and domain models to specific symbol level frameworks (knowledge representation languages), and concrete implementations.

Basically, our work is grounded on two foundations:

1. Modern Software Engineering (SE) principles should be integrated into Knowledge Engineering (KE). This is the only way how knowledge-based parts of applications can be methodologically build in a way that allows easy interaction with common business environments.
2. KE work should proceed within the boundaries of an established methodology that allows to define relevant milestones, to control project progress, and to relate conceptual modelling, design, and implementation.

Our work is particularly inspired by the KADS-I and KADS-II methodology. In common efforts of our projects BEHAVIOR and FABEL, we are developing a language MoMo that formalizes and extends the principles of KADS by providing executable models. MoMo is a graphical language to a very far extent. Its most important concepts are: construction and utilization of a library of generic PSMs with specifications provided as conceptual models; separation of concrete domain knowledge, more general domain ontologies and PSMs; separation of data- (inference-layer) and control flow (task-layer) within conceptual models; object-oriented analysis and representation of generic types within dataflow specifications; explicit links of generic data and functions from the conceptual model to the concrete, application-specific domain-layer; a prototyping- and reuse-oriented process model for developing applications; support of

selecting, combining, and customizing conceptual models for building large applications (not yet implemented).

In the German National Joint Project BEHAVIOR we apply MoMo as a tool for reverse engineering. BEHAVIOR deals with Model-Based Diagnosis (MBD) and Qualitative Reasoning as an approach that exploits structural and behavioral descriptions of devices in the diagnostic process. Our driving example is diagnosis of ballast-tanks of offshore-systems. We are using MoMo to capture conceptual models of a number of existing software tools for MBD, which have been developed by our project partners. These models should help a knowledge/software engineer who is not familiar with all the intrinsics of the underlying mechanisms of MBD to learn more about it and to start building applications. Momo should particularly provide support in the process of domain analysis, and in finding an appropriate MBD technique (out of several alternatives) satisfying the needs of the acquired domain characteristics.

The diversity of MBD tools have been integrated in a so-called workbench. This realises an implementation-oriented framework (Generic Diagnostic Engine – GenDE; developed by Siemens AG and Fraunhofer Institute for Information and Data Processing IITB). Principally one is free to configure tools and parts of them to a working GenDE instance. This work towards implementation-level modularization made it much easier for us to concentrate on the conceptual aspects of the tools. First, we analysed the functionalities of the tools and specified them in form of MoMo s inference and task layers. The inference layers were depicted graphically and specified in MoMo, based on the GenDE definitions. Second, we made these specifications executable by MoMo s interpreter with control over the problem-solving process residing at the task-level of the conceptual model. To this aim the definitions of actions and generic objects are linked via MoMo s view-descriptors to methods and data types of the implemented modules. ■

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REBOOT: REuse Based on Object-Oriented Technology

by Svein Hallsteinsen

Software reuse and object orientation are by most experts considered the two most promising methods for improvements in software technology. REBOOT is a project in the EEC ESPRIT program that will develop, test and disseminate an industrial environment with associated methods to support object-oriented software reuse.

REBOOT is carried out by a consortium lead by BULL S.A. (France). Other participants include: LGI (France, associated partner of Bull), CAP GEMINI INNOVATION (France), SEMA GROUP S.A.E. (Spain), SIEMENS A.G. (Germany), SINTEF (Norway), Q-LABS (Sweden), TXT (Italy) and Frameworks (Sweden, associated partner of Q-Labs). The project runs over 4 years from September 1, 1990, and has a budget of 19 MECUs.

Objectives

REBOOT will offer:

- A Software Engineering Environment, composed of tools to CREATE (identify, abstract, qualify, store) and to REUSE (retrieve, evaluate, adapt) software components. This environment includes a version of DBMS with high-level access tools, a graphical user interface (structural navigator/editor, tool activation), a reuse assistant integrated with traditional development tools (design tools, compilers, editors), and reverse engineering and metrics tools.
- An object-oriented method to develop reusable software components.
- Component models for different types of components.
- Methods for planned reuse throughout the lifecycle of software systems.

- A prototype repository, populated with general-purpose as well as domain-specific components. It will be possible to integrate this repository with different software development environments.
- Teaching material and courses to promote reuse.
- A study of the non-technical aspects (organizational, economical and legal), which will influence methods and tools for reuse.

A characteristic feature of REBOOT is its "holistic" approach: In order to develop successful methods, REBOOT will simultaneously address problems in all above areas.

Status

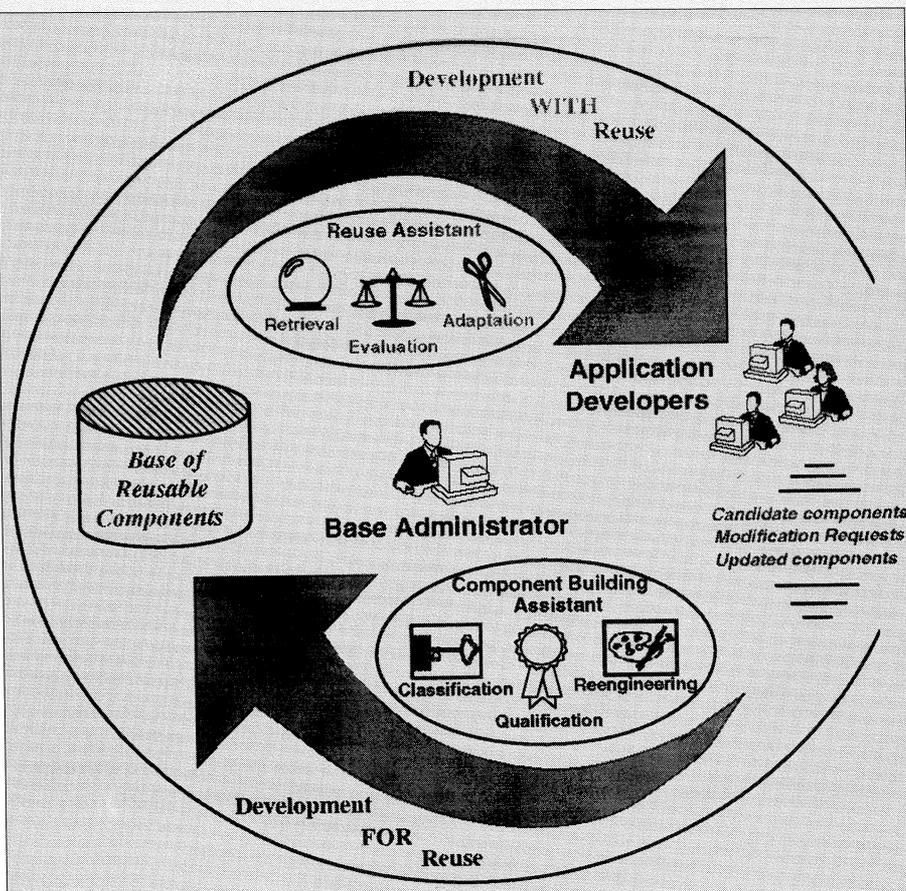
A first prototype of the environment has been released for evaluation together with preliminary results from the methodology work. It is based on existing or de-facto standards, such as Unix workstations, C++, the X Window System, and Motif. The initial choice for the version of DBMS is Adele from LGI.

An example component library has been inserted into the environment. It includes some components developed for this purpose, parts of standard class libraries and parts of the environment itself. Several applications are now in the process of inserting components for various application domains and experimental development with the support of the REBOOT component library are planned.

The design of a 2nd prototype is in progress.

The methodology is being consolidated and made more operational in the form of a reuse handbook.

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Reuse of Object Specifications

by Carlos Paredes

Reuse, and in particular inheritance, usually suffer from two problems: 1) it is applied too late, just in software construction, rather than in specification and conceptual modelling which is where the main effort should be placed, and 2) it is applied only to object signatures (ie, attributes and events), not covering their behavioural properties.

Attempting to tackle these problems, the Logic Engineering Group of INESC is working on object-oriented, logic-based modelling and specification of reactive systems, including concurrent information systems. In this approach, objects are defined by theories (called templates), each of which consists of a signature:

- attributes,
 - events
- and a collection of axioms describing the behavioural properties of the object. These include:
- for each event, safety conditions specifying when it may (or is permitted to) occur;
 - for each event, liveness conditions specifying when it must (or is obliged to) occur;
 - for each event/attribute pair, valuation expressions describing the effects of the occurrence of the event over the attribute.

There are a variety of languages for describing objects in such a model textually (eg. TROLL developed at the University of Braunschweig), diagrammatically (eg. OBLOG jointly developed by INESC and ESDI), etc.

Among the advantages of using such a formal and declarative framework, we may point out its suitability to:

- capture and support incomplete information (which is highly important in conceptual modelling);

- apply reuse at the early stages of development, and as soon as possible;
- refine specifications, by adding successive details;
- support reasoning about properties, consistency and completeness of specifications;
- support inheritance (through theory morphisms), not only of object signatures, but also of behavioural properties.

At the heart of reuse is the concept of inheritance, whose basic form specialization has the following meaning:

- new attributes and events may be added;
- safety conditions may be strengthened;
- liveness conditions may be weakened;
- valuation expressions, if not defined, may be added.

Specialization presents three levels of strictness:

- strict or "pure" subtyping,
- with side-effects (the new events may affect inherited attributes),
- with non-monotonic overriding (the inherited behavioural properties can be replaced by new ones).

Specialization with non-monotonic overriding can be described as an abstraction (the inverse operation of strict specialization) followed by a strict specialization, where:

- the intermediate object theory captures the features of the inherited object which are preserved, i.e. the features that are common to both objects;
- the abstraction morphism captures the features which were deleted;
- the strict-specialization morphism captures the new features which were introduced;

Reuse may also be achieved through composition of specializations. Here, it is important to emphasize the difference with respect to multiple inheritance. In multiple inheritance the two (or more) base object theories are "merged" (which raises problems such as undesired duplications and incompatibilities). In specification composition the two (or more) original specifications are combined (using categorical co-limits) resulting in a stronger specialization.

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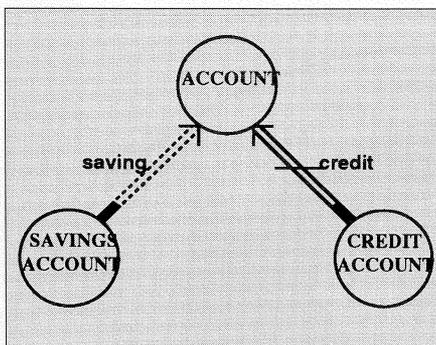
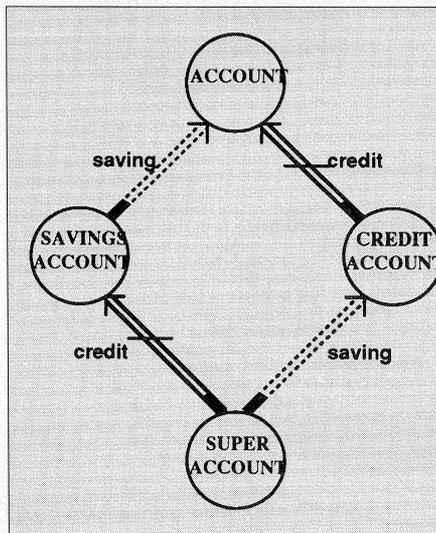


Diagram specifying:

- Savings Account as a specialization with side-effects of Account, because payment of interests (new event) changes balance (old attribute);
- Credit Account as a specialization with non-monotonic overriding of Account, whose safety for withdrawal events, forbidding the balance to become negative, has been deleted.



Super Account is a specialization of Account, which is achieved through composition of the previous specializations (saving and credit) in such a way that it can either be seen as a savings-specialization followed by a credit-specialization, or the reciprocal. This composition of specializations is computed through co-limits of the corresponding theory diagrams.

A Development Model as Reuse Support

by Jeanine Souquieres

Software reuse concerns the reapplication of a variety of "knowledge" about one system for the construction of new systems, and aims at reducing the effort of the development and maintenance of new developed systems.

Reusability should be supported at the various stages of software development. However, in most cases, significant reuse techniques only exist at the product level for source code components. Furthermore, these techniques consider reuse in the small rather than reuse in the large. Most of current approaches are empirical and no general ones are known to this problem. Recent studies advocate a definition of software reusability based on formal specifications increasing their reliability.

Development specifications together with their decisions and rationales are also candidates for reuse. In this framework, developments are considered as first-class objects allowing to edit them, to reason formally upon them, to check their properties, and so on. The construction of a specification is a sequence of development steps, a step corresponding to the application of a development operator on a development state.

Development operators allow reusability to be addressed, reusability of pieces of the product as well as reusability of strategies. Another interest of a development model, not exclusive of the precedent one, concerns the reuse of the requirement development or the possibility of replaying a development, since each single step - even a dead end - is recorded with its decisions and rationale.

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The CAMILA Strategy for Software Reusability

by José Nuno Oliveira

Traditional "pen and pencil" development of software misled people to think that program design dispenses with specific development tools. Software "in the small" appeared to be an attractive, cheap technology, but lack of technological sophistication "in the large" has frustrated such expectations.

A basic problem with software development is the fact that code is hardly reused, that is, it is difficult to produce a large software system by composition of smaller, readily available, software components. This has an obvious impact on increasing software production costs.

Software reusability is hindered by several reasons, some of which are even non-technical in nature. But relatively recent interest on effectively promoting reusability in CASE technology tends to invert this situation. However, most CASE systems are oriented towards production management (versioning, documentation, team management, etc.) rather than to the end product. This may be so because their designers could probably not understand what a software product really is. So software modules are regarded as mere text-files, their essence never being recorded. For many programmers, software re-use simply means "do not start from scratch: edit an existing source file". Software component repositories are built but either record trivial information or remain empty.

The CAMILA group at INESC/University of Minho, which is involved in the SOUR project (EUREKA 379), believes that reusability cannot be achieved by simple *ad hoc* means, even when addressed from a novel, object-oriented perspective. The basic question - "what is a software component?" - has to do with software specification, and can only be

properly answered in a formal context. This is because some kind of metrics will be required to automate the basic operations over a software component repository, namely classification, comparison, retrieval and modification. Thus, CAMILA's strategy for building a software component repository is based on characterizing every software component by its formal specification, understood as a piece of data (internal state) and associated basic operations (events) which are described using set theory. A CAMILA component may thus be regarded as a model as in the VDM methodology, but CAMILA's notation can also express the specification of a component as the functional composition of already available sub-components.

Furthermore, CAMILA's formal notation has been studied with the view to devise a metrics for component classification. Its associated calculus, SETS, can be used not only to classify components (in a "classify-by-data" style) but also to calculate component implementations or to compare them (by calculating their difference). Thus, architectural relationships in the repository such as *is-a*, *is-used-by*, *is-implementation-of*, *is-special-case-of* are formally decided rather than fixed by the users intuition.

In CAMILA, priority has been given to methodology foundations before going into the development of technological support tools. But rapid prototypes can already be built in the CAMILA software environment by running a language animator which is, itself, an exercise on reusability (the current version of the animator, developed using the Synthesizer Generator, still reuses a hidden LISP interpreter, augmented with the language primitive constructs and used in the past to interpret manually encoded prototypes).

CAMILA component aggregation can also be expressed by software-circuit diagrams, using a graphical notation suggestively resembling the conventional hardware notation. But diagrams should never replace formalisms - every software-circuit has a proper semantics and is just a shorthand for some piece of mathematics.

Other tools under development comprise a SETS-calculator, a performance prospector and an automatic generator of user-interfaces at prototype level. ■

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Using Formal Methods for Reverse-Engineering.

by Jerome Loubersac

Reverse-Engineering, the process of understanding a system or program, is often a prior step to the maintenance, re-engineering or reuse of existing code. At RAL, an experiment in Reverse-Engineering using the VDM specification language is being carried out (research sponsored by BULL S.A.-France). The aim of this work is to define techniques for obtaining an abstract formal specification from a program (COBOL code and, in the near future, C as well).

The prospect of integrating the advantages of formal methods into a Reverse-Engineering process is quite attractive, and some attempts to achieve this goal have already been made. In our approach, we use the Vienna Development Method (VDM) and specification language (VDM-SL). The Reverse-Engineering task can be decomposed into two steps:

- the first step is to translate the code into a VDM specification at a low level of abstraction. This is made possible by the wide spectrum nature of the VDM specification language, which includes imperative constructs as well as very abstract ones (e.g. set theory, quantified expressions, etc).
- the second step consists of gradually transforming this "concrete" VDM specification to obtain an abstract one. This process of abstraction can be considered as the inversion of the process of refinement (used in formal devel-

opment to build a system from its specification), and can be done either by applying proven transformation rules or by using symbolic evaluation to obtain elements of an abstract specification.

The program is specified by a single operation called PROGRAM. The precondition for this operation is a conjunction of two predicates: one defining the initial state and the other one defining the well-formedness of the inputs. Whilst the first one can be directly deduced from the program itself, the second predicate expresses some constraints which must be extracted by analysing the program in order to trace "how" the input data are used by the algorithm. The postcondition is also a conjunction of two predicates, one stating that the execution has terminated (in order to characterise the final state of the system), and the other one stating that a relation between inputs and output exists. This predicate should capture the "meaning" of the program ("What" it does). It is the aim of the second step to retrieve this predicate, because what we first obtain, by translating a code into VDM, is actually an implementation (explicit operation definition) of this specification (implicit operation definition), i.e. describing an algorithm (the "How"). We are to achieve this abstraction in any of the following ways, by:

- symbolic evaluation,
- applying transformations rules which capture known and proven abstractions,
- offering a frame for the writing and proof of original abstractions.

In all cases, we wish to formally prove the correctness of the proposed abstraction, and the formalism of VDM enables us to do this.

So far, several experiments of translating COBOL programs into VDM have been conducted, and a formal specification of this translation has been written and will be used to develop a prototype translator. Some transformations (restructuring of IF-THEN-ELSE, elimination of GOTOs) or abstractions (program termination mechanism, FILLERS in data, etc.) are automatically performed during this translation. To facilitate the trans-

lation (and future analyses necessary for the second step), we use the parser and tools designed for the intermediate language BN, developed within Bull for the static analysis and symbolic evaluation of COBOL and C programs. The study of the abstraction process has now just begun. ■

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MOORE: Object-Oriented Renovation of Existing Software

by Hartmut Fergen

Information technology and its products are changing so rapidly that even new software is already out of date before the customer uses it. The situation is even worse for old software, whose structure, appearance and functionality, in spite or because of continual maintenance, neither represents the state-of-the-art nor satisfies the user requirements. Sooner or later, when major changes are proposed, the question arises as to whether existing software should be modified again or replaced.

The present situation of the user is characterised by a decreasing dependence on major hardware and software suppliers and their conventional support for application programming. A long-term objective must be the reduction in the amount of specially written software by using standard software. This implies standardisation of information and data structures ("unified data model") and the rationalisation of procedures and techniques, leading ultimately to a formalisation of company organisation.

The purpose of MOORE is to support the technical renovation and rationalisation of programs and data by providing methods and tools for the stepwise transformation of existing software into object-oriented form (e.g. from COBOL85 into OOCOBOL). The maintenance personnel for the existing software should be able to participate in this transformation, but will probably need retraining.

In the Esprit project REDO reverse engineering is used on the original source code to produce a specification suitable for input to the code generator. This theoretically elegant method is difficult to apply in practice because of limitations in the experience and number of personnel available. Consider for example the transformation of a large program complex with all its historical peculiarities and irregularities.

With the MOORE prototype, which is being developed, the work proceeds interactively on a terminal, where the user influences directly how old software is stepwise renovated and transformed into object-oriented form. The user has a leading role in this operation and is supported by the system using techniques which are algorithmic, heuristic, and defined by the user. The objects discovered in the transformation are stored for revision and further use. These stable and mature objects are then used for both the further refinement of existing programs and the development of new programs.

The use of such a technique provides a practical and economic method of gradually transforming old software using existing maintenance personnel.

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The relationship between the platform and the two pilot systems.

Knowledge Re-use in a KBS for Water Distribution Companies

by Simon Lambert

In many domains in which knowledge-based systems can be applied, there is scope for knowledge reuse. The Knowledge Engineering Group at RAL has developed a knowledge-based system for a consortium of UK water companies. It is called the Water Distribution Expert System, and assists operational staff in managing a water supply and distribution network.

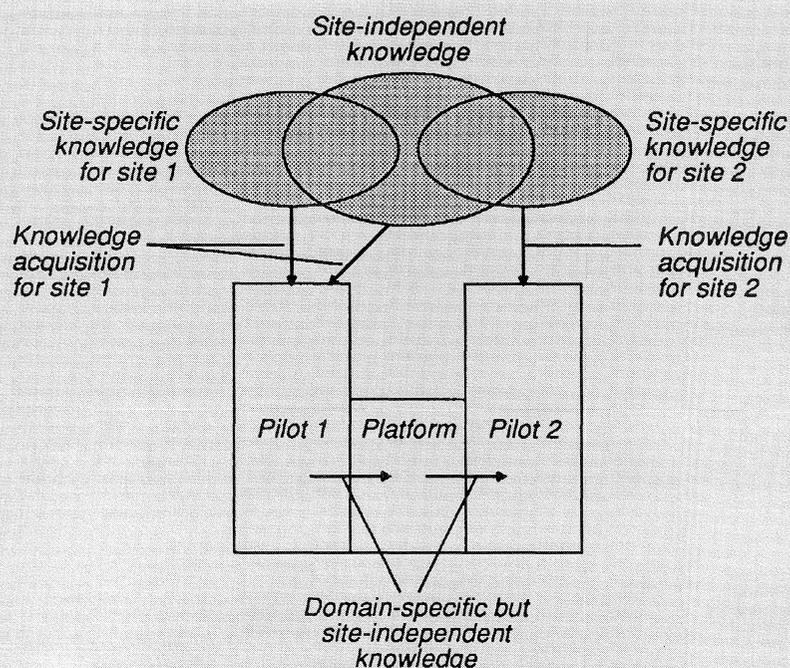
The development was funded by eight water companies; it was not possible to build individual expert systems for them all, but it was important that they should all receive a clear result from the project. The answer lies in knowledge reuse: one of the chief deliverables is the "platform", which embodies knowledge specific to the domain of water supply and distribution, but independent of any particular site. The diagram illustrates the way in which the platform is developed from

a first pilot system, and shows how knowledge acquisition and development effort for a second pilot is reduced when the platform is available.

The system comprises three knowledge-based components: a model of the water supply network, a Situation Assessor which analyses and reports on developing conditions as the model is run, and the Option Generator whose function is to suggest actions which may be taken to solve or alleviate problems. Each of these uses different representations and reasoning techniques, and is developed in different ways (e.g. the role of knowledge elicitation with human experts). The analysis of the different forms of reuse and how to obtain the greatest benefit was an important task in the development of the platform.

Two customized pilot expert systems were built and delivered, the second being based on the platform. Benefits were found in savings in knowledge elicitation and analysis effort, in system development, and in validation and testing. The developers feel that this approach to knowledge reuse could be applied to other domains, and could be generalized to classes of similar domains (e.g. water and electricity supply and distribution).

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Computer Graphics

PREGO: a Second Generation Graphics Standard

by Klaus Kansy
and Peter Wisskirchen

Efforts into the direction of the so-called second generation graphics standards are well underway. GMD has organized four workshops at Ehlscheid where experts from Germany met to define the focus of such a standard. As a result, an Initial Draft was developed and presented to the International Organisation for Standardization (ISO).

After a long time being a specialist's area, computer graphics became a rapidly evolving area in the last decade. Today it is present on all modern workstation, at the user interface as well as in many application areas. This is reflected by heavy requirements put on the graphics system.

Since the first computer graphics standards, GKS and PHIGS, had been fin-

ished, it was clear that more powerful graphics standards are required to serve the expanding needs of applications and to focus the diverging trends in current graphics systems.

The German Standards Institute (DIN) has proposed a project of a second generation standard named Programming Environment for Graphical Objects (Prego) and has volunteered to provide an Initial Draft. In preparation of the Prego standard, GMD has organized experts meeting at Ehlscheid (Germany) where the scope and purpose of Prego were to be focused. Finally, a first version of an Initial Draft was written which describes Prego in some detail.

Prego concentrates on computer based generation and interactive manipulation of visual information including sound. Prego defines a framework into which components modellers and renderers can be combined to form a uniform system. By this approach Prego defines an open system, which can be extended by further components.

Configurability, extensibility and customization can be achieved by the component/framework approach as well as by using the object-oriented programming paradigm.

The notion of time dependent objects is addressed as a major pre-requisite of multiple media support and included as an

integral part of Prego. Sound objects can be added as attributes to graphics objects. Although the Initial Draft does not cover all relevant aspects of the future standard, it is useful to convey major ideas of the intended standard and to clarify its structure in a more concrete way than is done in the project proposal.

Computer Graphics standards have been of special interest for GMD as well as other ERCIM institutes. For example, the first graphics standard, GKS, has been developed under strong participation of ERCIM members: The editors of the GKS document came from GMD and RAL; the convenor of the respective ISO working group came from CWI. It is the intention of graphics people in ERCIM to be heavily involved in the second generation standards also. ■

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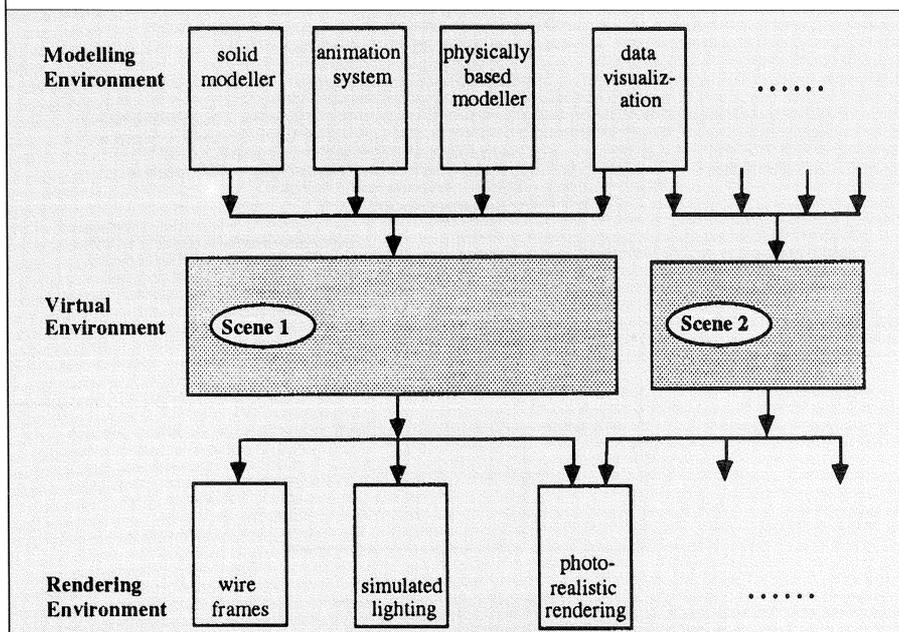
Software Assessment

Effective Software Quality Evaluation

by Hans-Ludwig Hausen
and Dieter Welzel

Repeatable and unbiased quality evaluation is required to improve software quality and to increase process productivity. As a solution to this problem an evaluation method has been designed and applied to several case studies within the ESPRIT Project SCOPE (Software Assessment and Certification Program Europe). The method is based on dedicated models for software products, software processes, software quality characteristics, and evaluation methods and tools.

The method comprises five general steps, which produce key documents. In the requirements specification the mandatory product and process attributes are iden-



The scene as mediator between different modellers and renderers

tified. The evaluation specification identifies the detailed information on product, process and quality attributes needed to effectively measure software quality. This leads to an evaluation plan defined by evaluation modules. Each module defines the methods for verification, validation, measurement and assessment, which have to be applied to evaluate a software attribute. The final evaluation report contains the evaluation results obtained from module applications. All evaluation documents together provide the necessary information for software certification. The method can work with customized models as well as with standards (e.g. ISO 9126, ISO 9000 to 9004). An Evaluator's Guide has been produced, which is now in the review process by the ISO-group SC7/WG6.

Prototype implementations have shown that the evaluation method can be implemented by rule-based systems as well as on standardized software engineering platforms and can be embedded into well-defined software process models. The evaluation method is furthermore refined and validated in two waves of case studies. At present we are working on a platform for software quality evaluation

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Abstract Interpretation Laboratory

by Fosca Giannotti, Diego Latella and Gianni Mainetto

A consolidated class of formal techniques for static program analysis, known as *abstract interpretation* (AI), originates from research in the 70's on partial, symbolic and mixed evaluation and owes its mathematical framework to Cousot and Cousot. AI aims at acquiring information about the dynamic semantics of a program to be used by compilers, partial evaluators and debuggers, or merely as documentation.

For example, logic programming has successfully used AI to detect properties like groundness and goal independence thus providing efficient specialised parallel execution. Functional programming uses AI to detect strictness and reference independence for efficient graph reduction and optimised garbage collection.

The AI laboratory will test these technologies in various contexts such as database programming languages, specification formalisms, concurrent programming languages and object oriented languages. At the moment, two experiments are under way:

Data Sharing Analysis for Database Programming Languages

The evolution of DataBase Programming Languages (DBPL), which provide a unifying framework for data definition and manipulation, opens up opportunities for the transfer of technologies between the database and programming language areas. Persistent programming languages (PPLs) are the subclass of DBPLs in which the data model is completely integrated in a programming language. In particular, if a PPL is based on formal semantics, formal methods for designing, transforming and optimizing database programs can be exploited. An investigation of whether, which and how such formal methods can be successfully put to work in the database context should be very challenging.

Within this framework, our first experiment consists in defining an abstract interpreter for a persistent programming language, namely a subset of Galileo. The aim is to detect safe parallelism for transaction operations scheduling. Transaction operations can be safely interleaved when there is no overlapping among their readsets and writesets. Given the text of the transaction and the conceptual schema of the data stored in the database, the abstract interpreter automatically derives an approximation of the readset and writeset of the analysed transaction. It is worthwhile noting that the goal of the analysis is to count the accesses solely to shareable and modifiable persistent data structures. The information obtained is passed to the scheduler before transaction operations are exe-

cuted. In this way, a scheduler that implements a conservative two-phase locking protocol for a persistent programming language is obtained without the transaction programmer needing any specific information.

Lotos Specification Transformations

Our second experience concerns the LOTOS formalism, an ISO standard specification language for open distributed systems. A software development methodology based on LOTOS has been developed as a result of the ESPRIT-LOTOSPERE Project. This methodology supports system designers and implementors along the trajectory from an initial, abstract specification up to concrete design and implementation and is strongly based on the notion of correctness preserving transformations. Gate splitting is a simple and useful transformation which, given a specification P, returns a specification Q, insisting on a different set of gates but preserving the behaviour of P. Technically speaking, P and Q are strong observationally equivalent up to injective renamings of their events.

We provided an efficient solution to the gate splitting problem which makes use of abstract interpretation. The original contribution of this work stems from the fact that the abstract domain is automatically generated from the particular specification. This is quite uncommon in traditional uses of abstract interpretation where the definition of abstract domain depends on the optimization at which the analysis is aimed. Abstractions for user-functions as well as for the gate splitting criterion are then computed using this domain. The transformation which is performed as a function from LOTOS expressions to LOTOS expressions uses the information gathered by the abstract interpretation as an extra-parameter in order to reduce the code of the output specification.

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Networking

What's going on in Satellite TDMA Systems

by Erina Ferro
and Nedo Celandroni

FODA/IBEA is a TDMA satellite access scheme developed and implemented at CNUCE-CNR, which allows simultaneous transmissions of synchronous and asynchronous data while efficiently counteracting fade effects caused by bad atmospheric conditions, especially in the K_a band. Its test-bed is the Olympus satellite.

Research in the satellite networking field started at CNUCE in 1978 with STELLA, the first European experiment in data transmission via satellite, and continued with other projects, like the New Satellite Bridge and SATINE I/II. In 1988, CNUCE began studying and experimentally implementing private satellite networks, with economy and flexibility as the main goals. Such networks, commonly called business type user oriented networks, allow the satellite to be accessed directly by means of an antenna installed on the roof of the user premises.

The Time Division Multiple Access technique was chosen as offering the maximum flexibility, mainly achievable via software. The channel speed was limited to 8 Mbit/s to constrain the antenna dimension (2-3 m. diameter) and the earth station costs (antenna, power amplifier, tracking system). It was decided to operate at variable coding and bit rates of the data for the sake of cheapness and flexibility. In this way satisfactory data quality can normally be maintained, depending on the transmitting station capacity and/or signal fade caused by bad atmospheric conditions. Such satellite networks are used for standard EDP applications (file transfer, mail, remote login, etc.), also called *datagram traffic*, in addition to other applications, such as

voice, video-conferencing, tele-education, etc, called *stream traffic*.

Stream traffic is characterised by a constant packet arrival rate. It requires short and fairly constant delay; it can tolerate occasional bit errors and dropped packets but not out-of-order delivery of packets. In practice, stream traffic needs a fixed amount of bandwidth on a regular basis as possible and the satellite network should maintain a low, constant delay on the arrival of information.

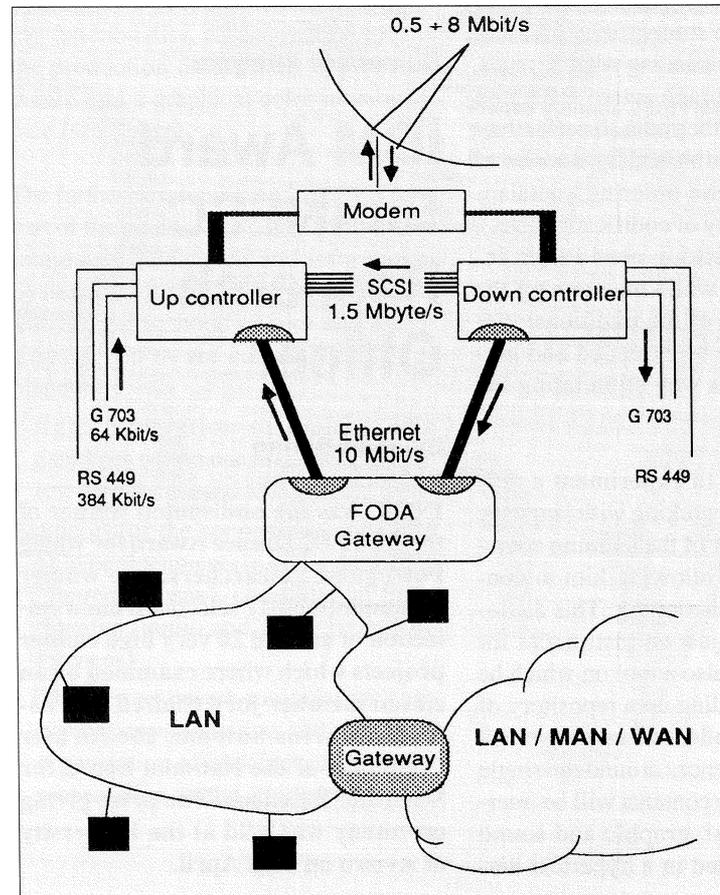
Datagram traffic is sub-divided into *bulk* and *interactive* types. In bulk data traffic, the speed at which packets are sent and the delay introduced by the network(s) crossing are not critical constraints. Generally, there is not the rigid delay required by speech and out-of-order delivery packets. However, especially on a high delay network such as a satellite one, the end-to-end throughput of such traffic can be heavily impaired by bit errors or packet losses.

Interactive traffic (terminal access to computers, database enquiry, operator message exchange, etc.) demands error free, reliable delivery and short delays to guarantee acceptable response times. It

often consists of short messages (a few characters) with unpredictable inter-arrival rates.

Rain attenuation and signal depolarisation occur because individual raindrops absorb energy from radio waves and some energy in the waves is scattered out of the propagation path. These interactions depend on the number of raindrops encountered and on their size and shape. Above 10 GHz, attenuation caused by rain has a significant effect on the availability of microwave links. Many techniques, known by the generic title of *fade countermeasures*. (site diversity, cross-band frequency diversity, etc.) have been proposed to alleviate this problem.

However, CNUCE is currently only interested in fade countermeasure techniques operating in TDMA. Many experimental programs on the Olympus satellite are conducted in Italy including the "Thin route TDMA" and "Thin route TDMA for LANs interconnection" projects. The first, coordinated by CNUCE, aims at tuning up a satellite access scheme supporting isochronous and anisochronous traffic, capable of efficiently counteracting the fade of the signal under bad atmospheric conditions.



The network scenario

Once the satellite access network has been tuned up, the second must create a suitable environment. Different terrestrial LANs supporting different end-user applications should be interconnected via satellite.

The Fifo Ordered Demand Assignment/Information Bit Energy Adaptive system is comprehensive of the FODA/IBEA-TDMA satellite access scheme and of the hardware prototypes (TDMA controller and burst rate modem) produced by Marconi R.C. (UK) mainly under CNUCE specifications.

The basic principle used by FODA/IBEA to cope with different levels of signal attenuation is the variation of the energy contained in an information bit. This is done by varying the transmission power, when possible, the data coding rate (in the range 1, 1/2, 3/4, 7/8) and the data bit rate (in the range 1, 2, 4, 8 Mbit/s). Punctured codes are used, based on a K=7 convolutional encoder and a Viterbi decoder which, given a sequence of encoded bits, attempts a maximum likelihood sequence estimation to predict the original information bit sequence. Other rate codes can be derived from the 1/2 rate code by deleting (or "puncturing") bits periodically in the encoded sequence and inserting erasures at the decoder to produce a 1/2 rate sequence. High data rates are used under unfaded conditions, when the signal-to-noise ratio is sufficiently high. The data rate is also progressively reduced when deep fading occurs to make the decoder work with a suitable value of the E_b/N_0 (bit energy over noise density) ratio and to allow acquisition by the modem in a reasonable time interval.

A new protocol has been developed (GAFO protocol) for communications between the FODA/IBEA system and the outside environment. The system began testing on the Olympus satellite in the K_u (12/14 GHz) band on February 1993; it will also be tested in the K_a (20/30 GHz) band.

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Project EPOST: a Message Handling System

by Bjørn Myrstad

The result of the EPOST project is a message handling system which is capable of delivering printed letters to physical recipients.

The EPOST system is implemented in a Intel 486-based PC running SCO UNIX, and is based upon an original version developed by OSIware Inc, Vancouver, Canada, for Canada Post Corporation using clustered VAX/VMS systems.

The VAX/VMS to Intel-486/SCO UNIX transition is performed by SINTEF DELAB for the General Directorate of Post in Norway. In this process, a large number of VAX/VMS specific system services are substituted with SCO UNIX counterparts. When such counterparts have not been available, new services have been developed.

The basic idea behind the EPOST system is as follows. A user with an email User Agent composes a letter and addresses a recipient in the physical domain. This address is either mapped onto 1988 style X.400 physical address attributes directly, or mapped onto special domain defined address attributes which have been defined for use by 1984-style User Agents.

An integral part of the complete letter address comprises the routing part, pointing to the EPOST MTA. Hence, the MTA servicing the user, will be able to transmit the (electronical) letter to the EPOST MTA.

The EPOST MTA will decode the address components of the letter, and render the letter for printing on a high quality laser printer.

The user may invoke preregistered logos which will appear on the first page of the letter. He may also address global distribution lists. In his letter he may also include PCL-encoded documents (PCL: (Hewlett Packard) Print Command Language) provided the PCL-sequences in these documents do not exceed predefined values.

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Distributed Systems

ALADDIN: Algorithmic Aspects of Parallel and Distributed Computing

by Henk Nieland

CWI is the main partner in a nationally funded four-year research effort into the algorithmic foundations of information processing in computer networks and multi-processor systems. Knowledge transfer is an important issue in this project.

Research into distributed algorithms has been somewhat lagging behind in volume in The Netherlands, compared to the international level. Therefore the Dutch National Facility for Informatics stimulation programme provided in 1991, as one of its last allocations, substantial funding in this field. The aim is to create a national platform out of the previously rather isolated research efforts, by educating and training young researchers, by generating sufficient expertise and knowledge to successfully apply for further funding on the national and Euro-

pean level, and by transfer of the gained knowledge to third parties.

Research topics include:

- global distributed computation on networks;
- distributed control of such computations;
- interprocess communication;
- computation of boolean functions with distributed inputs on anonymous networks;
- algorithms for distributed control;
- wait-free concurrent objects;
- computation models for future fast networks and real-time systems.

Activities concerning knowledge transfer include regular seminars and colloquia on (algorithmic aspects of) parallel and distributed computation, as well as several national and international workshops. An important aim of the project is the development of educational material in the field of distributed algorithms. ■

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Integrated Distributed Information Systems in Norway

by Bo Kähler

Distributed enterprises consist of organizational units which are geographically or logically separated. This causes opportunities as well as disadvantages. How do we exploit existing and new information technology together with knowledge about organizational aspects to make the most of the opportunities and reduce the disadvantages?

This is the question addressed by the IDIS (Integrated Distributed Information Systems) program which has been initiated in Norway this spring. The norwegian society counts 4.2 mill citizens (less than 1/18 of Germany) covering an area of 324 km² (about the same size as Germany)! This background gives the best opportunities to profit on IT supported cooperation and work.

Technology vs. organizational aspects

But technology is never better than the manner in which it is used. The top level goal of IDIS is therefore to increase the level of efficiency in norwegian business. This is to be reached by making enterprises able to optimize their organizational structure with respect to the tasks to be performed, and next, to make an enterprise able to cooperate with other enterprises whenever fruitful.

Keywords to achieve this are:

- use existing technology more effectively
- introduce new technology faster and goal-oriented
- identify optimal combinations of work processes, organizational structure and the application of different technologies.

These aspects are explored along three different dimensions: cooperation, case management and cooperative systems development.

Cooperation support

New cooperative technologies are emerging, such as electronic mail, interactive video and EDI.

What opportunities does the new technology offer and how does this affect the organization (e.g to coordinate information, experiences and decisions), and conversely; how does new organizational solutions affect the requirements of technology?

Case management support

Case management systems, or other types of work flow systems are getting increased attention in the press. IDIS will focus on what the potential for such sys-

tems could be and how various categories of products are supporting the concepts.

Aspects of this are:

- to establish a general functional specification for case tools for trade and industry
- to evaluate consequences of different ways of organizing the case management process
- how to achieve an optimal flow of information inside an organization.

Cooperative systems in decentralized organizations

The system development process is being decentralized, thus at one time getting closer to the user – but also further away from the experts. To obtain the real benefits of this, companies must engage in new methods, techniques and tools.

Also, a new infrastructure has to be in place, comprising of co-operating systems and databases in client/server architectures, knowledge about consequences of different organizational structures, as well as user oriented, model based systems development. Finally, a new model must be developed for organizing the tasks related to information systems development, maintenance and support in such organization.

Education is an important aspect of the IDIS program. The program will support 25 Phd-degrees

Common effort

IDIS is a collaborate effort between The Norwegian Research Council and an industrial consortium covering different business areas such as oil, engineering, finance and transport. It is planned to cover 120 manyears over a four year period. The work is carried out by the members of the industrial consortium, supported by research institutes (mainly SINTEF) and universities (mainly the Norwegian Institute of Technology). ■

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Human-Computer Interaction

Access to GUIs by Blind People

by Constantine Stephanidis

GUIB (textual and Graphical User Interfaces for Blind people) is one of the projects of the TIDE Pilot Action programme (Technology Initiative for Disabled and Elderly People, CEC-DG XIII). This project aims to provide the technological means which would ensure continued access by blind users to the same computer systems and computer-based applications used by sighted users.

Existing GUIs are inaccessible by blind users due to the fact that they have been designed to exploit the visual capabilities of sighted users and do not support non-visual interaction methods. Commercially applied solutions for the partial accessibility of GUIs (textual components) by blind users are not considered satisfactory. In this context,

"satisfactory" means that a blind person can have access to the same information content and can use the interface at a similar speed to a sighted person, with affordable extra hardware and an acceptable level of extra training. If satisfactory solutions for blind persons to use GUIs are not found in the near future, they will find their employment possibilities severely restricted.

One of the activities of the GUIB project, addresses a short and medium term solution to the problem of accessibility of GUIs by blind users through the adaptation of existing GUI environments. This involves the design and development of a powerful tool to facilitate description of blind user interaction in a graphical environment and to enable combinations of acoustic and tactile media for presentation and access to graphical objects. This tool is mainly based on:

- A filtering mechanism for extraction of essential internal data from the graphical environment before their conversion to bitmap data.
- The definition of a formal language for handling filtered data and supporting specification of appropriate interaction methods for the blind user, through the

combination of speech, sound and braille output.

- A front-end module that hides the complexity of the formal language from the end user (the adaptations designer) and enables easy and quick customization of the screen reader on the basis of blind user needs and preferences.

Two graphical environments, MS Windows and X Windows, have been selected for demonstrating the feasibility of the adopted adaptation methodology.

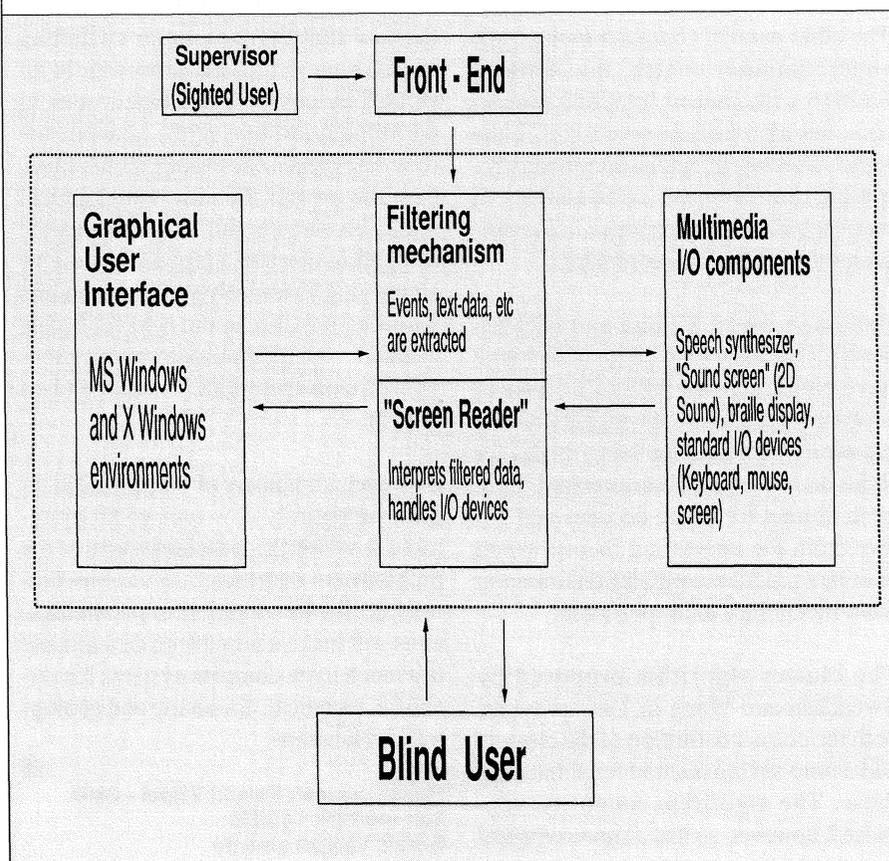
Another activity line of the GUIB project has a longer term objective, and is concerned with the development of innovative User Interface Software Technology aiming to guarantee access by blind users to future computer based interactive applications. In this respect, investigation is currently under way, aiming to provide the appropriate epistemic basis which would facilitate the efficient development of User Interfaces concurrently accessible by sighted and blind users. One of the major technical objectives of this work is to specify the appropriate technological tools which would allow a higher level (i.e. without requiring programming effort) development of shared dialogues, supporting the role of dialogue designer, both for visual and non-visual interaction.

Furthermore, the GUIB project is developing user navigation facilities through 2-D sound generation, mechanisms for image description / exploration for blind users and a prototype display based on the integration of tactile and acoustic media and the provision of means for executing "point" and "select" tasks.

The GUIB consortium partners are CNR-IROE (Italy), FHP (Germany), IFI (Germany), FORTH-ICS (Greece), RNIB (UK), TUB and FUB (Germany), VUB (Belgium), VTT (Finland).

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GUIB adaptation methodology.



Scientific Successes in GMD's Supercomputer Centre

by Roland Völpel

Scientists see a broad spectrum of future-oriented applications for parallel computers both in the research sector and in the field. This was the conclusion of computer experts after they had had the opportunity to work with two new parallel computers at GMD for a period of half a year. One of these new parallel computers is the "Connection Machine CM-2", the other is an Alliant-FX2816.

"Connection Machine MC-2" consists of a network of 16,384 individual processors which are interlinked in the form of a nine-dimensional hypercube. As a high-performance example of SIMD supercomputers (SIMD stands for Single Instruction Multiple Data), the CM-2 is particularly well suited for high-dimensional problems of massively parallel applications and belongs to the Cray-YMP 8/832 performance class.

Within only a few months of the CM-2 being installed, scientists at the supercomputer centre were able to record their first successes with large-scale simulation, Dr. Gregory Kohring of the Jülich supercomputer centre and the University of Cologne employing new methods for simulating the behaviour of fluids, so-called cellular automata, and developing algorithms which allow larger systems to be handled at higher speeds than formerly possible with supercomputers.

Simulation using cellular automata can be regarded as a middle way between calculating the paths of individual molecules (as is the case in molecular dynamics) and resolving classical fluid equations. Scientists regard this method as very promising for overcoming as yet unresolved problems in simulating the extraction of crude oil from porous rock.

The first task resolved by Dr. Kohring was the development of an efficient algorithm for implementing the cellular automata on the CM-2. This was possible by using a "multi-spin coding" technique which was developed on conventional

computers and recently enjoyed exceptional success in simulating neuronal networks.

This algorithm allows even greater speeds to be attained on the Connection Machine than on a Cray-YMP processor. What is more, through efficient memory utilisation, four times as many particles could be handled at any one time. (Both cases in this comparison involve world record speeds for these applications: 270 million operations per second on the CM-2 with 16k processors.)

The scientific results were a direct consequence of these new capabilities. While earlier simulations with ten million particles suggested an anomalous flow behaviour, the simulation on the CM-2 was able to handle around 200 million particles. It has now been demonstrated that the anomalous effects were a consequence of the small number of particles. This paves the way for further simulations which will be able to provide more reliable predictions on the flow behaviour of oil in subterranean rock.

The other parallel computer in the GMD supercomputer centre, the Alliant-FX2816 with sixteen Intel/860 processors, has also proven successful in the rapid handling of scientific projects requiring time-intensive computations. It has also provided experience in the programming of parallel computers.

Professors János Kertész and Dietrich Stauffer from the University of Cologne have employed the Alliant to resolve problems of statistical physics on the cluster dynamics of the Ising model for fluids and magnets. These problems have been around for many decades and derive from the nucleation theory which also has practical applications ranging from metallurgy to air pollution.

The cluster algorithm proposed by Swendsen and Wang in 1987 provides both the correct definition of the clusters and a time-saving method for simulating these. The algorithm cannot be vectorised, however, so that a supercomputer

of type Cray-YMP (Jülich) or NEC-SX3 (Cologne) is not suitable for processing these problems.

A single i860 processor performs each molecule simulation in around 2 microseconds, a rate comparable with a large IBM 3090 processor and four times faster than a Sparc2 workstation. The Alliant computer allows eight i860 processors to operate simultaneously if a relatively minor adaptation is made to this program. This reduces the processing time to 0.2 microseconds per molecule, some ten times faster than is currently possible on the fastest single-processor computers.

The Cologne scientists cooperating in some areas with Enrique Miranda and Harald Puhl from the supercomputer centre in Jülich were thus able to demonstrate in many hours of computing time that the observed cluster dynamics are consistent with traditional theories. It may soon prove possible to explain the dynamics solely from the geometric characteristics of the clusters.

Parallel computers such as the CM2 and Alliant which possess a higher computing capacity through the simultaneous use of multiple processors have become increasingly important recently due to the fact that the maximum switching speed of an individual processor is restricted by physical parameters such as the velocity of light or the quantum effect. The closer one comes to this limit, then the greater the cost and technical outlay involved in further increasing the computing speed of a processor. Only by employing massively parallel systems will it be possible in the next few years to attain a computing speed of one thousand million operations per second (Teraflops).

However, computers of this type also require an entirely new type of programming in which the individual parts of the program are distributed to various processors. The development of parallel systems will make it possible to develop and test much more complex systems for scientific, technical, economic and ecological applications.

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New Technologies in CNR Project to Boost Italy's Industry

by Bruno Fadini

The main scope of the "Information Systems and Parallel Computation" project is to assist the nation's industry to increase its competitiveness within the international market through the acquisition of new and more sophisticated technologies. The project specifically regards processor and parallel architectures, programming languages, databases, and software engineering and decision support systems technologies.

The Project is grouped into three main areas and divided into 8 sub-projects.

Scientific computation for large systems

This area regards the application of supercomputers and parallel computers to scientific problems of general interest from computational mathematics to supercomputer access networks.

SP1: This sub-project (coordinator Dr. Laura Moltedo) studies models, numeric simulations, programs and codes to solve highly complex problems in the field of mathematics, physics, chemistry and specific application fields. The main results consist of programs and codes running on supercomputers with global or distributed memory for industrial applications, libraries of scientific software for the above fields and for scientific visualization, and the creation of centres for software acquisition and distribution.

Processors, architectures and languages

This area conducts research on basic hardware and software components for information systems. It is divided into three sub-projects:

SP2: Dedicated Processors (Prof. Franco Denoth) designs and develops hardware/software modules for signal analysis, image processing, computer graphics and AI. The main results are the development of pre-competitive prototypes of transputer-based modules for image analysis and synthesis (including SAR), signal analysis of neuronal circuits, and a parallel co-processor for PROLOG.

SP3: Parallel Architectures (Prof. Marco Vanneschi) studies and experiments innovative parallel architectures mainly based on general purpose, massively parallel MIMD systems, with distributed memory. The principle results are the set-up of design methodologies and techniques for these systems at different abstraction levels and the implementation of pre-competitive prototypes.

SP4: New Generation Languages (Prof. Franco Turini) studies programming languages based on non-imperative paradigms, such as functional, algebraic, logic, concurrent, and object-oriented languages. The main results are the creation of environments for both product development and property proving; in particular, logic and concurrent programming and specification environments have been developed.

Software systems

This area comprises three sub-projects.

SP5: Advanced Database Systems (Prof. Domenico Saccà) aims at defining innovative database systems that support sophisticated applications dealing with complex objects, multimedia and heterogeneous data (possibly stored in distributed environments) as well as providing flexible, user-friendly database interfaces that increase the usability of current systems. The main results can be summarized in an extension of problems concerning object-oriented databases, the development of an advanced system nucleus combining logic programming and databases, and of a multimedia database system.

SP6: Methods and Tools for System Design (Prof. Carlo Batini) investigates the development of innovative methodologies, technologies and tools for software engineering. The main results

consist of methods and tools for software production, with significant contributions in requirement specification, analysis, prototyping, reuse, and reverse engineering, as well as within different application domains such as information system management, real-time systems, office systems and statistic systems.

SP7: Supportive Systems for Intellectual Work (Prof. Cesare Maioli) conducts research on the formalization of the decisional process, the representation of methods for problem solving and the use of tools by the intellectual worker. The main results are the construction of pre-competitive prototypes which use different knowledge representation and management paradigms to introduce well-defined professional figures into decisional support systems (i.e. immunologists, naval engineers, musicians, mathematicians, production controllers) in different applications (e.g. building recovery, braking systems, linguistics, diagnostics, gastroenterology).

SP8: Supportive Initiative (Ing. Stefano Trumpy) provides computational supportive for parallel computation and software engineering.

ISPC has a 5-year life-time: the first three years concentrated on basic theoretical and applied research; in this second stage the initial results are now being implemented in a number of pre-competitive products of scientific and industrial interest. The fifth year will be dedicated mainly to industrial transfer activities.

The project has certainly contributed to improving the Italian presence in the international scientific and industrial scenarios. Particularly significant has been the production of prototypes such as computational codes, programmes, and hardware/software products. ISPC has also been very active in collaborations with other initiatives with similar scientific goals, and especially with a number of ESPRIT projects; it is hoped that co-operations with European projects, also including ERCIM partners, will increase in the future.

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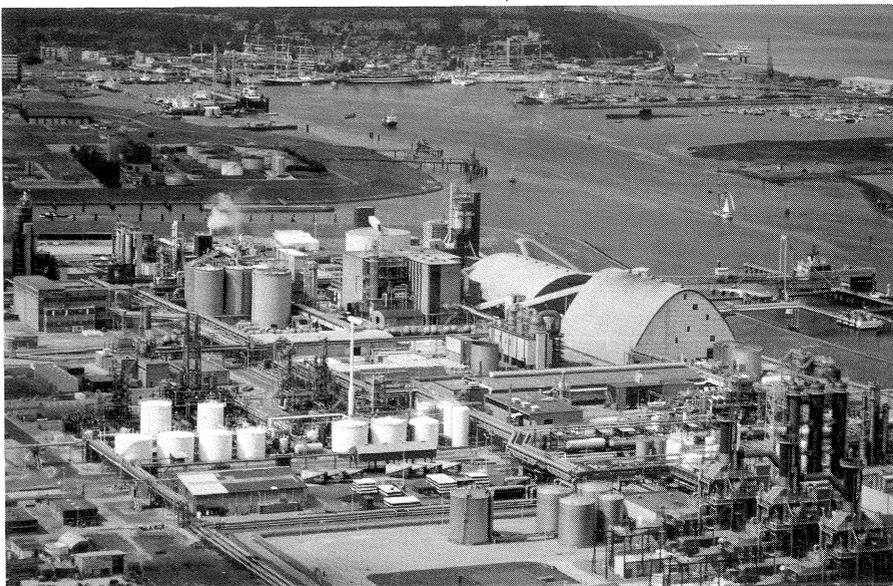
Parameter Identification

by Henk Nieland

Linking up with an earlier consultation project with the multinational chemical company AKZO, CWI now participates in a Dutch Technology Foundation 4-year research project on parameter identification and model analysis for non-linear dynamical systems.

In several industrial and laboratory settings, e.g. in fields like chemistry, biochemistry and pharmacy, there is a need for good methods and techniques for determining unknown parameters in the models employed. These models describe time-dependent, complex processes, possibly with several feedback mechanisms, and are formulated in the form of a set of initial value problems or as differential-algebraic equations.

From the data obtained by measurements one may try to determine the unknown model parameters, which leads to a better understanding and control of the process. However, experimental data contain errors and any method for computing the unknown parameters from these data should necessarily also indicate the uncertainty in the parameter values. An



AKZO plant at Delfzijl. CWI pursues research into parameter identification in complex models for chemical and other processes. (Photo: AKZO)

important question is to decide to what extent one may derive parameter values from the available experimental data (it may be not possible at all). Another question is whether there are dependencies between the parameters: is there more than one model fitting the data? Also the model's consistency with the data should be determined.

Such questions can be successfully addressed with the help of state-of-the-art computing facilities, by supporting the mathematical solution method with a suitable interactive graphical user interface.

The research addresses the need in sciences like chemistry, biology, biochemistry, pharmacology and medicine for adequate tools to test and adapt complex non-linear dynamic models to experimental data. Its fundamental aspects are concerned with quality assessment of the model, new interactive numerical techniques, visual co-processing and visual representation.

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INTERNATIONAL RELATIONS

ERCIM-Russian Cooperation Network

by Pierre Népomastchy

Many members of ERCIM have had good scientific relations with former Soviet Union for more than twenty years. Since they cooperate with more or less the same CIS organizations, ERCIM has decided to create a cooperation network in Informatics and

Applied Mathematics, which should be funded by the International Association for the promotion of scientific cooperation with the scientists of the Independent States of the former Soviet Union, associations recently created by the EEC Commission.

This Network would involve from 50 to 200 researchers working on precise projects in offices rented in Russia and equipped with modern work stations. This idea has been approved in March 1993 by the CODEST. The level of funding by the Association will be decided in the near future.

As a first step, the Network will involve four ERCIM partners (CWI, GMD, INRIA

and RAL) and 19 Russian organizations, located in Moscow and Novosibirsk. In the near future, other ERCIM partners and organizations from other countries of former Soviet Union will join the Network.

Initial list of joint projects :

1. Computational Fluid Dynamics and Applied Mathematics
2. Probabilistic Methods and Simulation for Modelling of Large Networks
3. Visual Analysis on the Quantum on the 3-Body Problem
4. Simulation and Characterisation of Micro-optic Elements
5. Pattern Recognition and Adaptive Systems Design

6. Object-Oriented Modelling of 3D Interfaces
7. Analysis and Transformation Program of Optimal MIMD Processing
8. Compilers for High Performance Computers
9. Developing Transputer Technologies based on the new T-9000 Transputer generation
10. Design and Control of a Prototype Biped Robot.
11. Models for the formal semantics of reactive systems.
12. Object-Oriented knowledge bases, constraints propagation

A small "Task Force", composed of Michael Agi (GMD), Mike Jane (RAL), Michiel Hazewinkel (CWI), and Pierre Népomiastchy (INRIA) has been created within ERCIM to coordinate this operation.

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CNR opens an Office in Bruxelles

by Nicoletta Celli

A Liaison Office has recently been opened in Bruxelles for the promotion of relationships between the Italian scientific community, and in particular CNR, and the Commission of the EC. The Office, directed by Dr Giuseppe Roffi, is intended as a precise point of reference for all those operating or who intend to operate within the context of European research and development programmes and, in general, in initiatives of the European Community.

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President of INESC in Kyoto to Promote Intelligent Manufacturing Systems

by João Bilhim

"Manufacturing is a primary generator of wealth and his critical to establishing a sound basis for economic growth." This basic statement from the Terms of Reference for the Feasibility Study in Intelligent Manufacturing Systems sets the tone for the work led by the IMS International Steering Committee, composed of an industry led group of high level representatives of six Participants, during their 4th meeting in Kyoto, from April 5 to 6, 1993 at which Professor José Tribolet was present.

With the participation of six Participants (Australia, Canada, EC, five EFTA countries, Japan and USA) this unprecedented Feasibility Study Program selected six projects which started in February 1993. The positive contributions of nearly 140 companies, universities and research institutes will provide vital input to the decision making process from which final recommendations will be made early in 1994.

We are convinced that the fundamental principle on collaboration, stated in the IMS Feasibility Study Terms of Refer-

ence, that "Contributions to, and benefits from, such collaboration should be equitable and balanced", should be retained as a guiding concept when planning a possible full-scale IMS program.

In Kyoto, we began detailed discussions on the framework for a possible full-scale program. It is expected that each Region will make its own decision to participate in a full-scale program based on recommendations at the completion of the IMS Feasibility Study in early 1994.

It is time to take action on common international issues including global environmental problems, effective utilization of resources, improvement the quality of industrial life, globalization of manufacturing, and efficient transfer of manufacturing knowledge to the next generation.

A well-balanced regime for international R&D collaboration in intelligent, manufacturing could contribute to the development of the world economy. The IMS program could provide an effective mechanism to resolve common problems, and expand and open markets around the world.

Recognizing the above, the ISC has expressed its intentions to promote harmonized international relations through its work on a possible full-scale IMS program. The ISC has encouraged entities in all six Regions to consider the positive experiences gained through the IMS Feasibility Study in view of participation in the IMS program, if ratified.

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Prof. José Tribolet,
president of INESC,
Portugal.
(Photo: INESC)

GMD - the First International Member of the Real-World Computing Partnership in Japan

by Eckart Bierdümpel

In October 1992, the Japanese Real-World Computing Partnership (RWCP) formally accepted GMD as its first foreign member organisation. The primary goal of the Real-World Computing Program, a follow-on program of the fifth computer generation, is to research into future-oriented computer technology such as massively parallel systems, neural networks and optical computers.

Over recent years, a study has been undertaken in Japan into Real-World Computing (RWC), an area which the Japanese believe will lie at the very heart of information technology in the 21st century. The results of this study were published in March 1992 in a report entitled "The Master Plan for the Real-World Computing Program". Following this, a Japanese delegation travelled to America and Europe (Germany, France, the U.K. and the European Community) to talk specifically to interested parties. The German discussion partner was the

GMD. A meeting was held on 25 March to introduce RWC and to advise on the possibilities which existed for GMD's participation.

In June 1992, a number of Japanese companies founded the "Real-World Computing Partnership" with the aim of furthering the RWC program. Twelve Japanese organisations were founding members of the RWCP (Oki Electric Industry Co., Sanyo Electric Co., Sharp Corporation, Sumitomo Electric Industries Ltd., Toshiba Corporation, NEC Corporation, Hitachi Ltd., Fujitsu Ltd., Research Institute Tokyo Inc., Mitsubishi Research Institute Inc., Mitsubishi Electric Corporation and the Japan Iron and Steel Federation).

In close cooperation with the German Federal Ministry for Research and Technology, negotiations were conducted with the RWCP which were aimed at gaining admission to the Partnership. At the last Extraordinary Members' Meeting of the RWCP on 14 October 1992, GMD was formally accepted as the first foreign member organisation, although some legal problems still need to be clarified. The Japanese company NTT was also admitted at the same time. It is planned to admit the Swedish Institute of Computer Science (SICS) in March 1993. The European Research Consortium for Informatics and Mathematics (ERCIM) has also expressed an interest in membership.

One week after GMD became a member of the RWCP, GMD organised an RWC information seminar on behalf of ERCIM and at the request of the European Community. The seminar was attended

by 50 interested parties from industry and science throughout Europe.

In the meantime, the Japanese Ministry of International Trade and Industry (MITI) has officially made the RWCP responsible for conducting research for the RWC program. Most of the research funds will be provided by the Japanese Government. However, administrative costs and other costs not directly linked to the research work must be covered by member contributions. These lie between 10 and 35 million Yen. The RWC program will run for 10 years and involve a total cost of 60 billion Yen.

The Partnership has its own research facilities – the Tsukuba Research Centre – in the Tsukuba science centre near Tokyo. The centre is manned by research staff from all the member organisations and the Electronical Lab (ETL), a Japanese governmental research institute. Nevertheless, a significant proportion of the RWC program will be carried out on a decentralized basis at the research labs of the individual member organizations.

The fields of research will focus on theoretical principles, novel functions for application, massively parallel systems, neural systems and optical computer systems.

The master plan of the RWC program envisaged the research work continuing until 1 April 1993. All of the organisations which are members of the Partnership submitted at least one or even several project proposals. These were assessed by the "Review and Promotion Committee" set up by MITI. The official results of the evaluation were presented at the Plenary Meeting of the RWCP in March 1993. Two GMD projects stand a very good chance of being implemented. One of these, which deals with theoretical principles, looks at statistical inferences as a basis for genetic algorithms, while the other project examines the development, implementation and evaluation of a programming model for massively parallel systems.



Prof. Akinori Yonezawa, from the University of Tokyo, giving a presentation of Real-World Computing at Schloss Birlinghoven, GMD. (Photo: Münch, GMD)

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Fourth Eurographics Animation and Simulation Workshop

Barcelona, Spain,
4-5 September 1993

Image analysis and synthesis are essential tools for scientific knowledge, technological production, communication and artistic productions. Although works on animation exist since the very birth of image synthesis, it is today that a real general interest in the field of animation is to be expected, along with a diversification and an actual development of concepts and techniques. The goals of this workshop are to sum up the current concepts and techniques for motion analysis, synthesis and control and evaluate the major fields of animation applications.

Topics:

- Motion synthesis with collisions, deformations, fractures, living behaviour...)
- Motion generation optimization
- Languages and grammars for animation
- Motion analysis
- Motion perception
- Visualization process for animation
- Animation control
- Programming dynamical phenomena
- Electronic Prototyping (CAD for dynamic objects, Robotics...)
- Help for Knowledge (dynamic phenomena ...)
- Artistic Creation
- Virtual Realities

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World Transputer Congress

Aachen, Germany,
20-22 September 1993

The 1993 World Transputer Congress (WTC'93) sponsored by The Transputer Consortium (TTC) will be held simultaneously with the German national transputer Conference, the Transputer-Anwender-Treffen Conference 1993 (TAT'93).

Topics:

The conference themes include: education and training issues, formal methods and security, performance and scalability, porting existing systems, parallelisation paradigms, tools, programming languages, support environments, standards and applications. Specific Applications topics include: embedded real-time control systems, workstations, consumer products, artificial intelligence, databases, modelling, design, data gathering and the testing of scientific or mathematical theories.

There will be two main technical streams held at the Eurogress Conference Centre with the WTC'93 papers being presented in English, whilst the TAT'93 papers will be in German or English. Papers will be published in the Proceedings in the language of presentation though selected papers may be published in both languages.

There will be seven consecutive parallel sessions in both the WTC'93 and in the TAT'93 streams interspersed with common plenary sessions. Introductory and Advanced tutorials and workshops will take place on 23rd-24th September.

Deadline:

15 July 1993: Registration

Please contact:

The WTC Registration Office - RAL
Fax: +44 235 44 5893
E-mail: wtc@uk.ac.rl.inf

ICODP'93: International IFIP Conference on Open Distributed Processing

Berlin, Germany,
14 -17. September, 1993

ICODP'93 will have a special emphasis on ODP applications. Applications serve as evaluation for ODP modelling techniques and ODP-Functions. They provide important and typical examples of what should be amenable to ODP. Discussed will be applications in the fields of medicine, telecom, telepublishing and multi-media.

ICODP'93 will provide an opportunity to exchange experience and information about the recent activities of standardization bodies such as ISO, CCITT, ETSI, projects within R&D programmes like RACE, ESPRIT and AIM, and interest groups like CSCW and TINA.

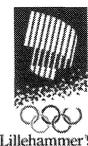
The organizational profile of the conference reflects its active working character. Leading experts will open sessions where refereed papers document current research trends. Shorter position statements will be targeted especially to industrial participants, either to present recent developments or to articulate problems for which support is requested. Facilities for tool demonstrations will also be offered.

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EUREKA Conferences



Lillehammer '94

Lillehammer, Norway,
13-16 June 1994

If you want to see what the host town for the 1994 Winter Olympics looks like, here is your chance. A series of EUREKA conferences will be arranged at Lille-

hammer next year. One of the conferences that will be of particular interest to the ERCIM society is on "Information Technology for Environmental Management".

The issue will be addressed by keynote speakers, through specialized paper presentation and poster sessions. This special conference is scheduled for 14-15 June 1994. At the end of the conference all the participants will join the EUREKA ministers from all the member countries for a plenary session expected to draw 3000-4000 people. And of course you will get a chance to tour the Olympic sites.

Topics:

Small workshops will be conducted on the following themes:

- sensors and remote sensing
- data processing and data quality control
- data transmission
- data bases for resources and the environment
- modelling
- data presentation
- decision support systems

A complete invitation booklet will be distributed in the fall this year (September-October).

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Workshop on the Development and Transformation of Programs

Nancy, France,
3-4 November 1993

This workshop is intended to address the scientific, technical and pragmatic issues involved in the development of specifications and programs using transformations.

Topics:

Topics include, but are not limited to:

- Formal transformations rules,
- Development strategies,
- Description of the program transformation process,
- Reuse and adaptation of programs,
- Tools and environments to support program transformations.

Deadline:

15 September 1993: Submission of contributions (full papers of 8 to 12 pages).

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Analysis and Optimization of Systems

Sophia-Antipolis, France,
15-17 June 1994

The 11th International conference on analysis and optimization of systems, organized by INRIA, will be the second specialized conference of the series. This time the specific field covered will be discrete event systems (DES).

Topics:

- The automata theory approach
- Hybrid systems
- The Petri Net approach
- The max-plus algebra approach
- Simulation, perturbation analysis, gradient estimation
- Large DES
- Manufacturing systems
- Telecommunication systems
- Parallel computing

Deadlines:

15 October '93: Full papers
 31 December '93: Acceptance
 20 February 1994: Camera ready papers

Please contact: François Tapissier - INRIA
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IC3A: Amsterdam Initiative in Complex Systems Research

by **Henk Nieland**

The Interdisciplinary Centre for Computer based Complex systems research Amsterdam (IC3A) is a joint initiative of the University of Amsterdam (Faculty of Computer Science and Mathematics) and CWI. The Centre was opened officially on May 17 during the HPCN'93 Europe Conference in Amsterdam.

At this conference some 200 experts from Europe and beyond discussed several aspects of High Performance Computing and Networking. From the political side reactions were given on the well-known Rubbia Report by representatives of the EC (H. Forster) and the Dutch Ministries of Education and Science (P.A.J. Tindemans) and Economic Affairs (J.J. van Scheijen).

IC3A aims at accelerating HPCN research by being a focal point in a network of interdisciplinary cooperation, with participation of the public and private sectors at the national as well as the international level. The research programme focuses on:

- computational methods and techniques to realise and support the study of complex systems in science and technology
- generic methods and techniques to create new computer functionality's and system integration.

Present computer facilities, operated by the Academic Computer Centre Amsterdam (SARA), include a 64-node Meiko and a 512 node T805 based Parsytec GCel-3/512. In July 1993, a 64 node T9000 based Parsytec GC-2/64 system will be installed (extension to 128 nodes before the end of 1993). Installation of an IBM scalable power system (SP₁) is under negotiation

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Prof. Enrico Garaci, the new President of the Italian National Research Council

CNR – **Prof. Enrico Garaci** is the new President of the Italian National Research Council. After graduating in Medicine at Rome University in 1966, Prof. Garaci immediately embarked on an academic career, becoming Rector of the University of Rome (Tor Vergata) in 1982. Since 1972, he has been a member of the CNR Committee for Medical Sciences and Biology and was appointed as its President in 1981, thus becoming a member of the CNR Advisory Board. He is a member of the National Council for Science and Technology of the Ministry for the Universities and Research (MURST), President of the Rome Research Consortium, and of the first Scientific and Technological Pole in Rome. The main research activity of Prof. Garaci, documented by more than 150 publications, is in the study of immunity defence mechanisms. Prof. Garaci takes over from Prof. Luigi Rossi Bernardi, who maintains an important role in CNR as President of the CNR Research Area in Milan.



Prof. Wolfgang K. Giloi, head of the Research Institute for Computer Architecture and Software Technology, GMD. (Photo: Münch, GMD)

GMD – **Prof. Wolfgang K. Giloi**, the head of the Research Institute for Computer Architecture and Software Technology (FIRST) at GMD and university lecturer on information technology at the Technical University of Berlin, has been honoured with the Officer's Cross of the Order of Merit of the Federal Republic of Germany (*Bundesverdienstkreuz*). Prof. Giloi has helped shape the

development of information technology in the Federal Republic from its early beginnings. In 1983, motivated by Japanese efforts to develop a fifth generation computer and with the active support of the Federal Ministry for Research, he founded the Research Centre for Innovative Computer Systems and Technology in Berlin which is operated jointly by GMD and the Technical University of Berlin. It is thanks to Prof. Giloi that GMD was the first foreign organisation to be granted membership of the Japanese Real-World Computing Partnership (RWCP).

INRIA – A compiler called MAVROS, developed by the RODEO project of Christian Huitema (INRIA-Sophia-Antipolis) has been licensed to BULL by INRIA. MAVROS is a tool for easy coding and decoding according to the set of functionalities of the language ASN.1. MAVROS facilitates the management of electronic mail and its portability is immediate, regardless to the operating system. IBM has confirmed its interest to MAVROS which should have a world wide diffusion.



Wolfgang Strobl, from the GMD Institute for Application-Oriented Software and Systems Technology. (Photo: Münch, GMD)

GMD – **Wolfgang Strobl** is a scientist at GMD Institute for Application-Oriented Software and Systems Technology. In November 1992, his Klotz program was awarded first prize in the games category of the international Microsoft Windows NT Shareware Contest which was held during the American computer fair COMDEX in Las Vegas. Windows NT (New Technology) is a new portable desktop and server operating system for CPUs from Intel, MIPS and DEC and is expected to be released for the middle of this year.

INRIA – Three new INRIA-NSF (National Science Foundation, U.S.A.) projects have been launched:

- Geometric Reasoning about 3-D objects, with collaboration between N.Ayache (INRIA) and G.Medioni (Univ. of Southern California)
- The Theory of Dynamic Games and Robust Controller Designs, with collaboration between P.Bernhard (INRIA) and T.Basar (Univ. of Illinois at Urbana Champaign)
- Simulation and Control of Constrained Mechanical Systems, with collaboration between F.Delebecque (INRIA) and S.Campbell (North Carolina State University)

INRIA – The overseas Bechtel Inc. will distribute O2, the Object-Oriented Data Base Management System of the company "O2 Technology" (start-up of INRIA), in Japan. The Japanese version of O2 will be launched in Tokyo in March 1993.



Prof. László Lovász, received the Brouwer Medal (Photo: Peter van Emde, Boas)

CWI – The Hungarian mathematician **László Lovász** has received the Brouwer Medal from the Dutch Mathematical Society. The medal, named after the famous Dutch mathematician L.E.J. Brouwer (1881-1968), is awarded once in three years to a mathematician of outstanding international reputation. Prof. Lovász is affiliated with Eötvös Loránd University in Budapest and Princeton University in the USA. He is well known for his work on the application of geometric methods to combinatorial and algorithmic problems such as polyhedral methods and the basis reduction method. He received the medal on April 15, after giving a lecture on "Combinatorics, computation, and topology" at the annual Dutch Mathematical Congress in Amsterdam.

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.

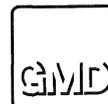
ERCIM News is the in-house magazine of ERCIM. Published quarterly, the newsletter reports on joint actions of the ERCIM partners, and aims to reflect the contribution made by ERCIM to the European Community in Information Technology. Through short articles and news items, it provides a forum for the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

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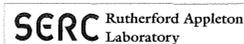
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