Canadian Artificial Intelligence
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Spring/Summer 1994 No. 34 printemps/été 1994

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Intelligence artificielle et Education

AI is Alive and Well and Living in Calgary
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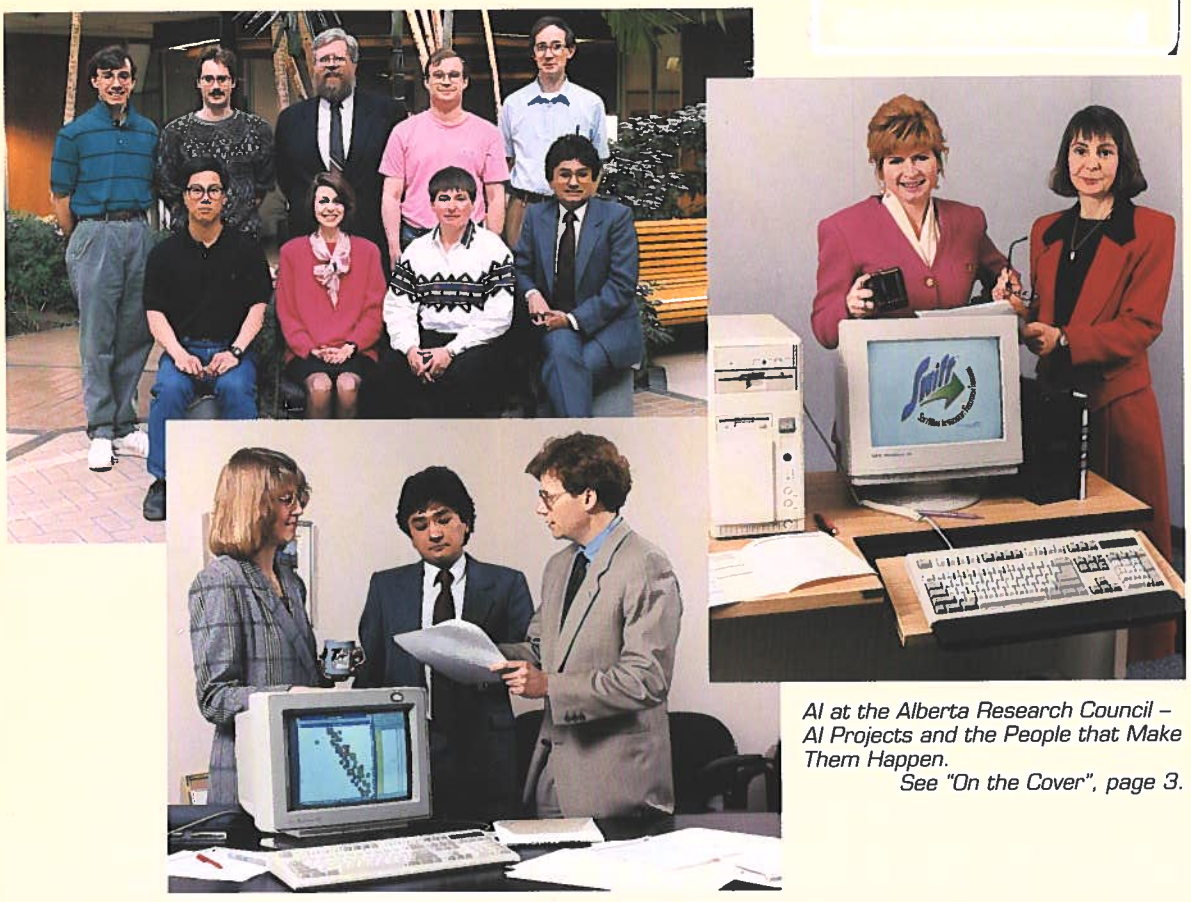

AI at the Alberta Research Council – AI Projects and the People that Make Them Happen.
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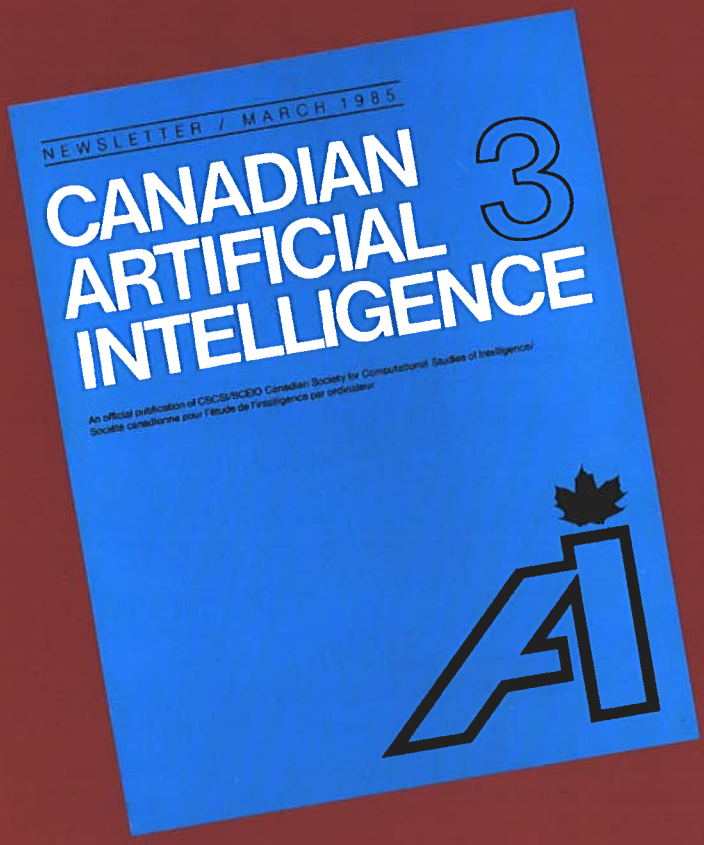
Retrospective



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Cover graphic, contents from Issue Number 3, March 1985 Canadian Artificial Intelligence Newsletter

Canadian Artificial Intelligence

Intelligence Artificielle au Canada

Spring/Summer 1994 No. 34 printemps/été 1994

Canada's National AI magazine.

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Goodbye and Taa-daa!

Every Monday morning, the chromosomes in a genetic optimization system are busy mutating and mating, avoiding the wrath of 11 fitness functions, to help optimize a province wide transportation system of a billion dollar Alberta company; shortly, whenever there is an emergency involving hazardous materials, a constraint propagation system based on hierarchical arc consistency will help identify the substance that is spilled so that several rule based expert systems can make a judgement of the risk of fire, explosion, and toxicity; one Alberta software company is looking at a 65 million dollar market from a recently launched product that is inspired by developments in enterprise integration research; another software company is poised to market new education software that incorporates advances in AI/Education; a leaf-spring manufacturer has diversified into the maintenance scheduling software business due to the success of artificial intelligence technology in their shop ... and on and on. If there is an AI winter, we are no doubt experiencing an extended AI chinook here in Calgary!

It is with a deep sense of personal pride for me to see the Alberta Research Council's Advanced Computing and Engineering Department profiled as this issue's Canadian AI success story. And what a story it is. From being the Canadian node in an international effort to develop a new virtual factory model for the future, to working on joint ventures with software companies to develop new products, to consulting contracts with larger firms to deal with difficult problems that have stymied other approaches, the Advanced Computing and Engineering department is just-a-humming ... and I have not even mentioned the non-AI stuff that is going on here!

Anyway, it is especially significant for me to have a tribute to my company in this issue, because the *Canadian Artificial Intelligence* editor baton is being passed on to the august National Research Council, to the more than capable hands of Peter Turney and Sue Abu-Hakima as the editors, and Arlene Merling continuing to provide the management and sanity. It has been great for me to have been a part of the CSCSI scene. I want to thank everyone for the support and help during my kick at the can.

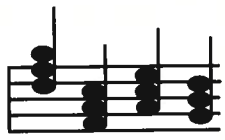
So, without further ado, over to you Peter and Sue!

Roy Masrani
April 7, 1994

THANK YOU ARLENE
THANK YOU CAROL
THANK YOU GREG

Before Arlene, Carol and Greg: "Are we going to make it this month?"; "Where is the article?"; "Roy...I did not get the last issue of the magazine"; "$(@*$@%)"

With Arlene, Carol and Greg: Hmmmmmmmmmmm...



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Hal-le-lu-jah!

Thank you, Arlene; Thank you Carol; Thank you Greg; and Thank you, Erika, for putting up with it.

Roy Masrani

Thank you, Roy!

On behalf of the exectutive of CSCSI and all of its members, I would like to express appreciation for the years of service that Roy Masrani has contributed to the AI community. As editor of *Canadian Artificial Intelligence* magazine, he has kept abreast of developments in a constantly changing field and tracked down contributors, who are not only willing to write articles, but write them for a deadline!

An editor's job is neverending; once a publication is completed, it is time to start again on the next issue. Roy has had an added challenge as editor - that of maintaining a high-quality magazine during a time of budget reductions. Clearly, he has met this challenge.

We are sad to see Roy step down, but appreciate his many contributions to the society - contributions that were totally voluntary.

We also welcome Peter Turney and Suhayya Abu-Hakima as incoming co-editors. A final thanks, as well, to the Alberta Research Council for their support of Roy and the magazine over the last several years, and to the National Research Council for their future support.

Janice Glasgow, President
CSCSI

On the Cover

Upper left photo: *AI Researchers, Advanced Computing & Engineering Department, the Alberta Research Council. From left to right, Back row: Greg James, Cam MacKenzie, Ken Gamble, Mark James, Jan Mulder. Front row: Vickett Lau, Linda Tauscher, Lynn Sutherland, Roy Masrani. Missing from photo: Marco Ariano, Richard Burdick, Aldo Dagnino, Danny Jaliff, Marlene Jones, Sheila McIlraith, Brian Schack. (Story page 20)*

Right photo: *From left to right: Kim Massie, President, Gemini Learning Systems, Inc., Marlene Jones, Senior Scientist, Alberta Research Council. (Story page 4)*

Lower left photo: *From left to right: Marni Balcom, HELIOS Project Leader, Merak Projects Ltd., Roy Masrani, Program Manager, Alberta Research Council, Brian Craig, President, Merak Projects Ltd. (Story page 11)*

Nominations CSCSI/SCEIO Executive 1994-1996

I am happy to announce the following as the nominations for the incoming CSCSI executive. The new executive will take effect after the annual meeting in Banff.

President - Stan Matwin, University of Ottawa
Past President - Janice Glasgow, Queen's University
Vice-President - Allan Jepson, University of Toronto
Secretary - Fred Popowich, Simon Fraser University
Treasurer - Peter van Beek, University of Alberta
Magazine Editor - Peter Turney and Suhayya Abu-Hakima, NRC

Janice Glasgow, President
CSCSI

AI and Education

Kim Massie, President, Gemini Learning Systems, Inc.

Résumé

L'abondance de recherche concernant l'approche á l'éducation et l'entraînement se rapportant á l'étude et au développement des environments d'apprentissage adaptifs, associés avec des techniques d'ordinateurs avancés, permet le développement de systèmes adaptifs avec comportement intelligence. SWIFT (Logiciel d'apprentissage intelligence á format libre) est un environment d'apprentissage adaptif créé et développé pour une recherche d'entreprise jointe entre Gemini Learning Systems, Inc. et l'Alberta Research Council.

Abstract

The wealth of research concerning approaches to educationand training that are relevant to the design and development of adaptive learning environments (ALEs) coupled withd advanced computing techniques allows for the development of truly adaptive systems with intelligent behaviour. SWIFT (SoftWare Intelligent FreeForm Training) is an ALE designed and developed in a joint research venture between Gemini Learning Systems, Inc. and the Alberta Research Council (ARC).

Gemini Learning Systems Inc. began offering training solutions for UNIX and open systems environments in 1989. In 1991 we began researching the market to determine the potential for computer-based training solutions, which quickly led to the world of artificial intelligence (AI). We discovered that in the field of 'AI and Education' there is a profound gap between academic research accomplishments and production systems. The last decade has witnessed substantial development of computing technology resulting in techniques and platforms for developing Adaptive Learning Environments (ALEs). This has been coupled with significant progress in basic and applied research in instructional psychology, providing models and rules for governing how these systems should teach [Winne et al. 1992]. The instructional potential of such systems is now generating much deserved excitement (for example, see [Jones and Winne 1992]). Effective and successful ALEs have been developed such as Smithtown [Shute and Glaser 1986, Shute and Bonar 1986], Sherlock [Lesgold et al.], STUDY [Winne et al. 1992]; however, few ALEs are available commercially. For example, both Smithtown and Sherlock have been developed in academic environments in the USA, largely funded by the U.S. Military. STUDY is a Canadian effort initiated by Dr. Phil Winne of Simon Fraser University. For a discussion of the effectiveness of ALEs, the reader is referred to an excellent paper by Valerie Shute [1990] in which four ALEs were rigorously evaluated and found to be superior to classroom instruction, reducing learning time by half or more, and increasing mastery.

This gap between academic research and industry seems to exist for several reasons. One of the primary reasons concerns the goal of academic research. The theoretical issues underlying reasoning about a learner's actions or intent are complex. Current research endeavours typically focus on solving such problems in entirety, requiring large amounts of inferencing and computing power. Solutions do not exist for scaled-down problems. For example, if one can assume that the target user is a co-operative and motivated learner, one can allow the user a certain amount of control. This frees the system from having to ascertain the intent of all user actions. This reduces the complexity of many of the underlying modelling or inferencing tasks that are undertaken by the ALE.

Much of the research that has been undertaken in AI and Education concerns techniques for the development of narrowly focused Intelligent Tutoring Systems (ITSs), the "cream of the crop" of ALEs. One can view computer-delivered instruction as a spectrum of possibilities from traditional Computer-Based Training (CBT) through to ITSs. The latter part of the spectrum are ALEs. Major advances have been made in the necessary technology and techniques for developing ALEs. These include: interface development toolkits, window management systems, multimedia devices (for incorporation of images, audio, and video when appropriate), learner modelling techniques, knowledge representation schemes for the representation of curriculum and domain content, diagnostic capabilities for observing and diagnosing learner's errors and misconceptions. Furthermore, immense computing power to integrate these techniques and technologies into ALEs is now available on portable machines.

In the spring of 1993, Gemini Learning Systems entered into a Joint Research Venture (JRV) with the Alberta Research Council (ARC). Members of the Advanced Computing and Engineering department and Gemini launched a project to design and develop an ALE *SWIFT* (SoftWare Intelligent FreeForm Training). ARC provided expertise in Human-Computer Interactions (HCI) particularly interface design, AI and Education, object-

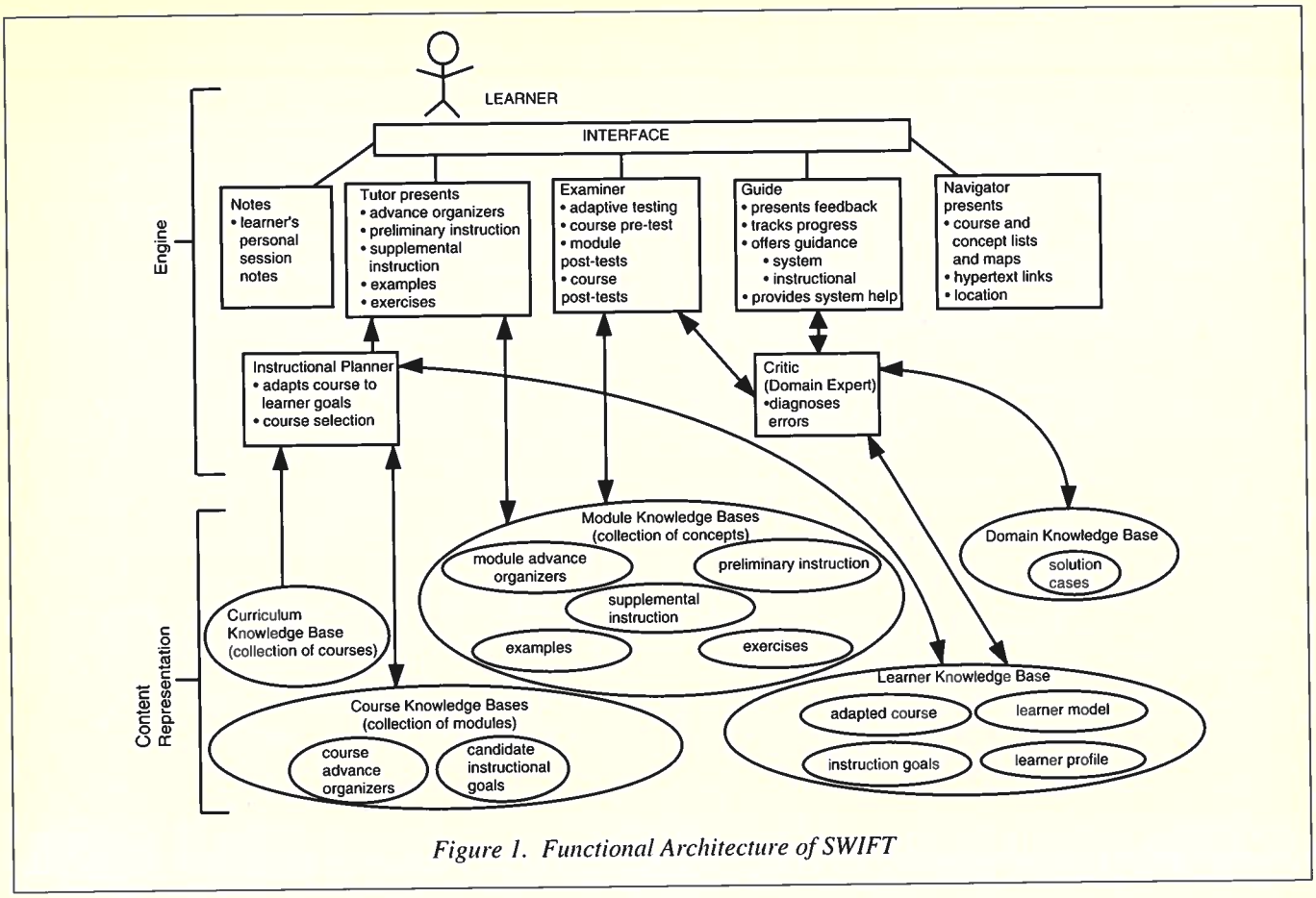

Figure 1. Functional Architecture of SWIFT

oriented programming, Window systems, software engineering and project management. Gemini also brought a wealth of skills to the project including expertise in Microsoft Windows, strong programming skills, training expertise, and in-depth knowledge of the market, customer needs, and commercialization requirements. The outcome of the JRV is *SWIFT*, an innovative product that is both flexible and robust for the delivery of courseware in a variety of domains.

We knew that our target audience consisted of highly-motivated, sophisticated learners. Gemini and ARC have designed *SWIFT* with the philosophy that the learner is in control while using *SWIFT*. This means that the system does not insist on any specified progression through the course material, but rather suggests an appropriate one for the learner. It is up to the learner to make the decision as to how to proceed through the material. Similarly, the system does not force the learner to undertake set activities in learning the material, but rather lets the learner initiate activities. Other examples of this philosophy pertain to the *SWIFT* pre-testing and post-testing. The results of any pre-testing are not binding, but rather are used to make suggestions to the learner as to which modules, or portions of modules should be undertaken. Similarly, post-testing performance results in a set of guidelines as to how the learner should proceed. The learner will, however, make decisions based on a range of criteria, including resources available (including time), his instructional goals, his desired mastery level, his motivation, etc.

SWIFT Architecture

The *SWIFT* system architecture consists of several system components which access and update various knowledge bases. The functional architecture of *SWIFT* is presented in Figure 1.

The system components include:

- User Interface
- Notepad
- Instructional Planner
- The Guide
- The Tutor
- The Examiner
- The Critic (Domain Expert).
- The Navigator

The user interface is the component with which the learner interacts. As such, it defines the appearance of *SWIFT* and how the user will interact with the application, i.e., physical movement through course material, how they access on-line help, how they quit the application, etc.

A Notepad allows the learner to keep personal session notes concerning the course they are currently taking.

The Instructional Planner adapts the course to the learner's

needs based on:

- the learner's instructional goals
- the learner's performance on the course pre-test.

The Guide tracks the progress of the learner, offers guidance as to where the learner should proceed in the course material based on his performance to date, and provides on-line help for the learner. The guidance offered to the learner is in two forms: current guidance which is a suggestion about what the learner might do next to facilitate learning in an efficient manner, and historical guidance. Historical guidance is advice that the learner has chosen not to follow; it remains accessible to the learner and may be followed at any time. For both current and historical guidance, the learner needs only click on the suggested guidance to invoke the necessary portions of *SWIFT* to undertake the suggested task. SWIFT's reasoning regarding guidance is rule-based.

The Tutor presents the course material to the learner; including preliminary instruction, supplemental instruction, exercises, and examples.

The Examiner tests the learner's mastery of the material at both the module and course level. All testing within *SWIFT* is adaptive in nature based on the work of Frick [Frick 92, Welsch and Frick 93]. Frick's approach to adaptive testing is rule-based and has been shown to be an effective and efficient approach to testing.

The Critic diagnoses errors and presents feedback to the learner. The feedback may include hints or additional information as to how to correct the error encountered and material that should be reviewed concerning the given errors. The learner is in control as to when the Critic presents the correct answer, if desired by the learner.

The Navigator presents the learner with several means of navigating through the course content, including hypersearch, navigation from concept maps and various content lists, and from a "location" window. This provides the learner with a variety of means to move through course material, as suites his individual needs.

SWIFT Knowledge Bases

SWIFT contains several knowledge bases:

- Learner Knowledge Base
- Curriculum Knowledge Base
- Course Knowledge Base
- Module Knowledge Base
- Domain Knowledge Base.

The Learner Knowledge Base consists of four smaller knowledge bases:

- Learner's Instructional Goals (one or more instructional goals that the learner has selected from a list of candidate instructional goals)
- Learner's Profile (e.g.: user id, password)
- Learner Model (exercises answered correctly, exercises answered incorrectly, diagnosed errors, performance on course pre-test, module post-tests, and course post-test, etc.).
- Adapted Course Knowledge Base (the modules or portions of modules that have been suggested for the learner based on the learner's instructional goals and the learner's performance on the course pre-test.

Instructional goals are established for each individual learner as to what he wishes to accomplish, i.e., someone who only wishes to learn basic UNIX commands versus someone who wants to learn about advanced UNIX system administration. The Adapted Course Knowledge Base contains information about the given course (for example, UNIX) as tailored to meet the individual learner's needs.

The Curriculum Knowledge Base contains a list of courses developed by Gemini or any other company. For example, the Computer Modelling Group, an international industry consortium with membership in 27 countries, is working with Gemini to develop *SWIFT* to train users on their reservoir simulation software.

The Course Knowledge Base is the collection of modules that together make up the entire course. The Course Knowledge Base contains ordering information, i.e., the conventional order in which a learner undertakes the modules that comprise the course. The Course Knowledge Base also contains a list of candidate instructional goals and a mapping as to which modules must be mastered in order to achieve each of the instructional goals. The Course Knowledge Base contains the Course Advance Organizer(s).

The Module Knowledge Base is the collection of information that is contained within each individual module that may be presented to the learner. It consists of one or more advance organizers for the module and a sequence of module concepts. Each module concept consists of preliminary instruction, supplemental instruction, examples, and exercises. There is only one preliminary instruction for each module concept and there may be one or more supplemental instructions. In addition, there are several examples and exercises for each module concept. The Module Knowledge Base includes ordering information, i.e., the conventional order in which a learner undertakes the concepts that comprise the module. The term Module Knowledge Based objects is used later in this document when referring to the items within this knowledge base, that is, the module advance organizers, the preliminary instructions, the supplemental instruction, the examples and exercises. The exercises also serve as test items for various *SWIFT* tests.

The Domain Knowledge Base contains the necessary domain expertise to allow the Critic to do its job of diagnosing the learner's errors. The Domain Knowledge Base contains case solutions that match a wide range of answers. The Domain Expert is part of the Critic, which determines the best-fitting case solution. The Domain Knowledge Base and the Critic are two important features that set *SWIFT* apart from traditional Computer-Based Training (CBT). These components allow *SWIFT* to provide meaningful feedback to the learner based on his individual answers to presented exercises.

SWIFT Course Compiler

Unlike authoring tools, which provide tools for course developers to design their own learning environment, *SWIFT* already has the environment created for the user. The developer does not require expertise in creating effective window interface designs, learning psychology, or applying artificial intelligence techniques.

SWIFT is available with a course designer guide and a compiler which provides the user with specifications for developing the course content and then compiles the course into the *SWIFT* ALE automatically. The course compiler allows the course developer to create and compile the necessary course goals, topics, modules, prerequisites, objectives, text, figures, diagrams, examples, and exercises. The material is stored in SGML (Standard Generalized Markup Language) which is then compiled into *SWIFT*.

Ongoing Research and Development

Gemini and ARC plan to continue their R&D work to further enhance *SWIFT*. A second Joint Research Venture (JRV) will be launched in April, 1994, with a budget of approximately $1.2 million. The primary objective of the proposed JRV is to extend *SWIFT* to be a fuller, richer learning environment that

- is suitable for a wide range of applications
- is suitable for a wide range of learners
- facilitates effective, efficient, motivating learning.

This primary objective will be achieved through enhancing *SWIFT* via the integration of new features and by the development of 3 new products: the Administrator's Environment, the Course Development Environment, and Multimedia *SWIFT*.

Enhancements to SWIFT

The enhancements to *SWIFT* encompass the following:

- Graphic Environment: Extend the current graphics capabilities to allow for more elaborate drawings.
- Diagnostic Capabilities: Develop full-scale diagnostic capabilities using techniques from artificial intelligence and cognitive psychology, building upon the research at the University of Saskatchewan.
- Tutoring Capabilities: Improve tutoring capabilities by enhancing the learner model and the system's instructional strategies. This will allow for more intelligent selection of exercises and examples, tailored explanation, and further adaptation of instruction.
- Application Experimentation Environment: Allow the learner access to application software for greater range of learner experience and experimentation.
- Simulation Environment: Incorporate the use of simulations.
- Enhanced Interface: Enhancement of interface capabilities to take advantage of human-computer interaction (HCI) benefits offered by graphical user interface (GUI) techniques including graphical representations of information, and variation of fonts, text styles, and colours of text.
- Motivation: Incorporate features known to enhance learning through improved motivation of learners, building on research in cognitive psychology and instructional sciences.
- Intelligent Adaptive Testing: Incorporate additional rules to allow for more intelligent adaptive testing.

The goal of Gemini and ARC's R&D is to continue to combine the flexibility of artificial intelligence, the effectiveness of cognitive psychology, and the motivation of educational psychology into an Adaptive Learning Environment that facilitate learning in an efficient manner. We have successfully produced the framework *SWIFT*. We will continue to enhance it with the techniques we know to create the most effective, efficient, and enjoyable learning, in conjunction with the development of supporting products (Administrator's Environment and the Course Development Environment) and associated products (Multimedia *SWIFT*).

Building on Canadian Research

Gemini and ARC plan to continue to build upon R&D from around the world in areas related to the design and development of ALEs. Of particular interest to readers of *Canadian Artificial Intelligence* magazine will be the enhancements to SWIFT's diagnostic capabilities. These are based on the internationally-recognized research from the ARIES (Advanced Research in Intelligent Educational Systems) Laboratory at the University of Saskatchewan.

Drs. Gordon McCalla and Jim Greer along with their research assistants and graduate students have developed an effective approach to diagnosing learner's errors and misconceptions. The approach is termed granularity-based diagnosis.

Granularity-based diagnosis is an approach to recognition which enhances both the effectiveness and robustness of model-based recognition. Instead of being in a flat data structure, models in granularity-based diagnosis approaches are arrayed into granularity hierarchies. This gives a recognition system the ability to back off to coarser grain sizes when finer-grained recognition fails. Robustness is further enhanced through use of cases. Essentially, once granularity-based recognition has been carried out to recognize some user behaviour, the resulting instantiation pattern is used as the basis for a case. Recognition proceeds first by "running" granularity-based recognition on some new behaviour, and then comparing the resulting instantiation pattern to stored patterns in a case library of such patterns. [McCalla et al.].

During the Gemini and ARC's first JRV, we undertook an investigation of current R&D concerning diagnostic capabilities within the research area of AI and Education. Based on this investigation, we felt that the research being undertaken at the University of Saskatchewan concerning granularity-based diagnosis showed promise of being applicable in a range of settings. Granularity-based diagnosis has been developed for use within Intelligent Tutoring

Systems [Coulman 1991, McCalla et al. 1992, McCalla and Greer in press].

The basis of granularity-based diagnosis is that a learner's answer generates an instance of a granularity hierarchy. The pattern of the learner's answer is then compared to the pattern of answers (correct and incorrect) in the case libraries. The answers themselves are not being compared (such an approach has limited applicability), but rather the instances of granularity hierarchies are being compared. The match may occur at a fine grain size allowing a detailed explanation. The match may only occur at a coarse grain size allowing only a general explanation. The plus, however, is that a match is always possible, hence always providing some appropriate and accurate explanation. These techniques have been successfully applied within a research setting to the diagnosis of errors in LISP programming [McCalla and Greer 1992].

As part of the first JRV, ARC arranged for a small experiment to be undertaken at the University of Saskatchewan. The experiment entailed the development of granularity hierarchies for a small portion of the UNIX programming domain (the course domain of the first JRV). The necessary reasoning and propagation algorithms were then applied to two problems that were developed by Gemini for UNIX script programming. This domain subset was chosen as it was deemed to be difficult in which to undertake diagnosis of errors, as a wide range of correct and incorrect solutions are possible. The diagnostic application was then run across the network from the University of Saskatchewan and demonstrated at ARC.

The success of the experiment has shown that granularity-based diagnosis is a flexible approach to diagnosis, worthy of further investigation and commercialization within ALEs. Discussions concerning the use of the intellectual property are underway between Gemini Learning Systems, ARC, and Drs. Greer and McCalla.

Future of ALEs

There is a wealth of research within Canadian universities and worldwide concerning approaches to education and training that are relevant to the design and development of Adaptive Learning Environments. This is coupled with advanced computing techniques such as those from the ARIES Laboratory at the University of Saskatchewan that allow for the development of truly adaptive systems with intelligent behaviour. Gemini is one company that plans to commercialize Canadian R&D with the assistance of the Alberta Research Council. Adaptive Learning Environments will make inroads into training and education because they are a vehicle for providing effective, efficient and enjoyable learning in a cost-effective manner.

References

Lesgold, A. and colleagues have produced a wealth of technical reports concerning Sherlock, Learning Research and Development Center (LRDC), University of Pittsburgh.

McCalla, G. and Greer, J., "Two and One-Half Approaches to Helping Novices Learn Recursion", in: *Cognitive Models and Intelligent Environments for Learning Programming*, Springer-Verlag, 1992.

McCalla, G. and Greer, J., "Granularity-Based Reasoning and Belief Revision in Student Models", in: *Student Models: The Key to Individualized Education Systems*, Springer-Verlag, in press.

McCalla, G. et al., "Enhancing the Robustness of Model-Based Recognition", *Proceedings of the Third International User Modelling Workshop*, Germany, 1992.

Coulman,R. *Combining Case-Based Reasoning and Granularity for Educational Diagnosis in an Intelligent Tutoring System*, ARIES Lab Report 91-9, University of Saskatchewan, 1991.

Frick,T., "Computerized Adaptive Mastery Tests as Expert Systems", *Journal of Educational Computing Research, 8(2)*, 1992, 187-213.

Jones, M. and Winne, P. (eds). *ALE: Foundations and Frontiers*, Springer-Verlag, 1992.

Shute,V., Rose Garden Promises of Intelligent Tutoring Systems: Blossom or Thorn? in *Proceedings of the Space Operations, Applications, and Research (SOAR) Symposium*, June 1990, Albuquerque, NM.

Shute V., and Glaser, R., *An Intelligent Tutoring System for Exploring Principles of Economics*. Technical Report. Learning Research and Development Center, University of Pittsburgh, 1986.

Shute V., and Bonar, J.G., An Intelligent Tutoring System for Scientific Inquiry Skills. *Proceedings of the Eighth Cognitive Science Society Conference*, Amherst, Mass. 1986, 353-370.

Welch, R.E. and Frick, T.W., "Computerized Adaptive Testing in Instructional Settings", *Educational Technology Research and Development*, 4(93), 1993, 47-62.

Winne, P.H., Butler, D.L.,McGinn,M., Sugarman, J.H., Jones,M., Mark M., Field, D., "STUDY: A Tool for Authoring ALE and for Advancing Instructional Research", Demonstration, the International Conference on Intelligent Tutoring Systems (ITS'92), 1992.

For additional information concerning Gemini Learning Systems and their product SWIFT, please contact ***Kim Massie*** *at (403) 263-8649 (phone) and (403) 261-4688 (fax).*

For additional information concerning the Alberta Research Council's activities in this and related areas, please contact ***Dr. Marlene Jones****, Program Leader, Learning and Collaboration, Advanced Computing and Engineering Department. Dr. Jones can be reached at (403)297-7585 (phone) and (403) 297-2754 (fax). Dr. Jones' email address is marlene@skyler.arc.ab.ca.*

For additional information regarding the ARIES Laboratory at the University of Saskatchewan, please contact ***Dr. McCalla*** *at (306) 966-4902 or* ***Dr. Greer*** *at (306) 966-4655. Fax number is (306) 966-4884. Electronic addresses are McCalla@cs.Usask.ca and greer@skorpio.usask.ca.*

The times they are a-changin' What's new at SFU's Centre for Systems Science

Connie Bryson

When Nick Cercone left the Centre for Systems Science (CSS) at Simon Fraser University in 1993, it was a big change — for him and for the CSS. The Centre was Cercone's baby. Under his leadership, it grew into a hotbed of innovative research in computers and communication, intelligent systems, and microelectronics.

But Cercone's departure (to an administrative post at the University of Regina) wasn't the only change to the Centre. Last year, its internal granting function was phased out. During the first five years of its operation, the CSS had made grants worth close to $1 million per year available to faculty. The money is now being used to fund new faculty and technical staff positions.

The current director of the CSS, Tom Calvert, notes that despite the changes, the mandate of the Centre remains the same — to help and promote the research of the systems science faculty. What is different is that the help no longer has a dollar sign attached to it. Help now means technical and administrative support and assistance with marketing and industrial contacts.

"Since I've been director, I've taken it as my mission to do a number of things to help faculty be competitive in terms of getting external money," Calvert says. "This includes developing proposals, setting up collaborations and managing very large contracts. We've had some success, but it's a slow business."

The shift in direction is a strategic response to the radically changed budget climate at Simon Fraser University (SFU), says Bill Havens, a CSS member and head of SFU's intelligent systems lab. "All three B.C. universities are having a financial crisis; provincial funding is down," he explains. "We're supposed to teach more students with no increase in funding.

"So at a time when the university is trying to make resources go further, it's not surprising that it looked at CSS as a source of resources. CSS is responding by trying to satisfy some of the university's needs and at the same time protect itself. That entails converting laboratory support and what had been a very innovative internal research program set up by Nick Cercone into permanent positions. In terms of the politics of universities, that's a good way to make sure the money doesn't get frittered away."

Havens says the phase-out of internal support will have an effect on research. In the intelligent systems lab, for example, development work on the Echnida CLP language will slow down. "We've been making good use of the internal support from CSS by going full guns on Echidna," Havens says. "Speaking selfishly, I'd rather have that support than not. But times change."

Nonetheless, Havens is bullish on the future, noting that his lab will have to redouble its efforts in seeking out external funding. He sees two advantages to the new funding situation: it will give his lab a greater presence in the community and make it more relevant to industry. At the same time, however, the increased emphasis on external funding brings some frustrations related to the targeted nature of industrial contracts.

"As soon as you're talking contract, it means a product," Havens explains. "Industry would like you to give them a disk that comes with an operator's manual and consulting time. But that's not the way universities operate. We're good at delivering technology, not software. Industry has a hard time understanding that.

"That's one of the reasons I'm happy to be involved with projects like IGI (the Intelligent Graphic Interface project run by PRECARN). PRECARN understands that what the university is doing is figuring out solutions, not delivering them in software. PRECARN has the right attitude about how university research can be delivered to the industrial community."

With all this talk of increased industry funding, does the CSS run the risk of turning itself into a series of development labs for industry? Not likely, says Calvert.

"My own feeling is that in our case we've got a long way to go before we get into trouble that way. I think that's the way it is with most universities. Nevertheless you've got to be very careful which contracts you sign — research cannot

CSS — What it is

The Centre for Systems Science acts as the local arm of the BC Advanced Systems Institute (ASI) at SFU. ASI was established jointly by the Canadian and British Columbia governments in 1986 as a centre of excellence for research and teaching in advanced systems including computing science, microelectronics, systems design, artificial intelligence, robotics, and aerospace. The CSS has about 100 faculty members, primarily from the computing and engineering departments at SFU but also from disciplines like kinesiology and psychology. Its three main research areas are computers and communication, intelligent systems, and microelectronics.

be secret, it must be publishable, it must have a sensible time frame.

"In the few instances where we've had misunderstandings with industry, it seems to me the problem was that people at the university were just unrealistic. They said they could do something in three months — in our time frame that's awfully short."

A new look

The new funding environment for university research has also meant changes to the structure of the CSS. Since its inception the Centre has been divided into three main research areas: computers and communication, intelligent systems, and microelectronics. In the past year, Tom Calvert has been busy encouraging the establishment of smaller research groups within the CSS. The Institute for Applied Algorithms and Optimization, the Institute for Human Factors and Interface Technology, and the Centre for Human Independence Engineering are three examples. In the process of forming are groups concerned with communications engineering and graphics and multimedia.

"The original broad research areas helped in terms of governing CSS but weren't meaningful in terms of research collaborations," explains Calvert. "They were just too big. The institutes and centres are typically groups of four to twelve faculty and their associated graduate students."

The CSS office provides these groups with infrastructure support such as secretarial help and assistance with developing a graphic identity (brochures, letterhead).

Calvert adds: "There are advantages to having a formal structure for these smaller research groups. When you go in for a collaborative research grant, it helps to have evidence that you are working together in a formal way. Brochures and letterhead — while they may seem rather insignificant — really do help to create that external identity."

Continuing on

While some CSS functions have changed, others remain the same. The CSS continues to run the research computing network for systems science faculty. Some of the funds that previously were directed to internal grants are now going into the network — to enhance it and make some staff members permanent.

"Our goal is to build on that," says Calvert. "The trouble with supporting any computing system is you always have to be looking at the evolution of platforms and operating systems. We must provide guidance on what we should be moving into. Even in computing science, there is a realization that UNIX on a Sun may not be the end of the world. We have to keep an eye on where it's all going."

The Centre also offers advice and secretarial help in the preparation of research proposals. A part-time person has been hired to help put together some of the major research proposals. "This helps but it's tricky," notes Calvert. "The help can only go so far because it's really only the researchers who know what they want to do." According to Bill Havens, the real stumbling block in preparing proposals is the lack of help with the administrative work needed to get the proposals out of the university.

"I can write OK but there's a tremendous amount of leg work involved in preparing these proposals — making 15 copies, faxing them here and there," Havens says. "The CSS takes on this role and it's very useful."

What's next

When Tom Calvert looks at the future of systems science research, he sees opportunity. He acknowledges this may sound odd given the state of the economy and government funding; however, Calvert feels there are more opportunities for research funding now than at any time he can remember.

"The challenge is to take advantage of the right opportunities — those that really do support research and graduate programs," Calvert says.

"There's a trap that academics can get caught in with research funding. You want to take on a new project because it's something new and very exciting. But at the same time, you must continue to support what you're already doing.

"At our university and at other universities, the base budget is less and less able to support research. And the typical NSERC operating grant is not enough. So if you have an operating grant, it's nice to have an NSERC university/industry grant along with some industry money and maybe funding from one of the networks of centers of excellence like IRIS (Institute for Robotics and Intelligent Systems).

"These funds should build on each other and give a researcher or a group of researchers the opportunity to do things. However, if the monies are pulling you in different directions, that's a strategic mistake. You end up having to administer all the different funds and it splits your research resources. I hope the CSS can help people sort out what the different opportunities are and avoid this trap."

Calvert adds that the new research funding situation has resulted in "key people being pulled in every direction." Various groups want these researchers to put in proposals or visit foreign countries.

"At some point they have to say no," Calvert says. "Even when expenses are paid, spending two weeks in Taiwan might not be the best use of their time. Government agencies that want to promote these kinds of liaisons have to recognize that universities need help — such as full-time research associates — if their people are going to participate.

"There are limits to what we as researchers can do. The biggest challenge over the next five years will be capitalizing on the opportunities without stretching ourselves too thin."

Connie Bryson *is a freelance writer based in Edmonton, Alberta, and a frequent contributing author to Canadian Artificial Intelligence magazine.*

Integration hits the oil patch

Monta Kerr

The Alberta oil patch is home to a new enterprise integration software package that is expected to improve industry-wide communications and access to information.

The product, Helios, is being developed by Calgary-based Merak Projects Ltd. and the Alberta Research Council (ARC). It will allow users to access information from applications and databases running on Windows, OS/2, Unix, Macintosh and other platforms. And, by incorporating artificial intelligence, it will be able to notify users of problems as they occur.

The idea behind Helios originated about two years ago, when Merak started looking at ways to create "seamless integration" between its oil and gas industry software packages.

Merak president Brian Craig said, "We first looked at our own products, and then we said, well, if we can do this for our own technologies, what about corporate-wide for a lot of the gas companies?"

So Merak teamed up with ARC on a $2 million enterprise integration project. They are now more than a third of the way through the two-year venture, and Craig said they are working on product installations for corporations such as Chevron Canada Ltd.

Alberta Research Council HELIOS team, from left to right: Richard Burdick, Brian Schack, Doug Brockelbank (Merak), Irvin Shizgal (Merak), Vickett Lau.

ARC program manager Roy Masrani said the development team wanted as much user input as possible, so it formed a steering committee, made up of representatives from Chevron, Gulf Canada, Mobil Oil Canada, Pembina Corp., and Petro-Canada, to help guide the product's development. Phil Black of Petro-Canada's resource division MIS group and a member of the steering committee, said, "It's a win-win thing. They get the benefit of surveying the market before they come out with a product, and we get the benefit of getting the product ahead of our competitors."

He said the committee has been consulted at almost every step of the way.

The first step was a geographic information system (GIS) interface, which Craig said is a necessity in a geographically-oriented industry such as the oil and gas sector. Then a communications architecture was developed, to ensure data could be shared between databases and applications.

Helios employs artificial intelligence, which allows a company to program suggested performance levels for different projects. If a project does not go as expected - for instance, if it is over budget - the system will automatically alert those involved, via e-mail or fax.

And it allows users to request reports, in whatever format they need them, using a "publish-and-subscribe method," according to Craig. This means users who want to know can be informed every time a certain database or file is updated.

Petro-Canada's Black said his organization plans to implement Helios, especially since he will get a "fiscal incentive" because he is on the steering committee. But at the moment he is having trouble finding people to test it. "We've identified a couple of areas where we want people to take a look at it. The tricky part is just finding some time. You need people to rip themselves away from work for a week or so to play with it ... to grasp what can be done with it," he said.

Masrani said the enterprise integration technology will have a chance to "prove itself" in the oil and gas industry, but ARC is also working with various software firms to develop applications for other industries.

He said announcements about health care and tourism applications may be made within the next six months, and added that ARC itself plans to be the first non-oil-industry user of Helios.

"This is one of the most exciting things we've done in a while," Masrani said.

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Call for Papers

Special Issue of Computer-Aided Design

Artificial Intelligence in Computer-Aided Design

Guest Editor: Professor John Gero
Key Centre of Design Computing
University of Sydney
Deadline for submissions: September 16, 1994
Expected publication: July, 1995

Artificial intelligence has provided a paradigm which has profoundly affected computing. It is also having a significant effect on computer-aided design by extending the ambit of CAD through symbolic computation and knowledge engineering. Earlier work concentrated on expert systems; however, recent research has broadened the focus to include object representation at one extreme to computer-based design processes at the other. Techniques based on artificial intelligence approaches are finding their way into practice.

This special issue will be devoted to new research results and novel or significant applications in industry related to artificial intelligence in computer-aided design. It aims to provide a milepost in this field by defining the state-of-the-art. An exceptional tutorial paper covering important but not widely understood topics will be considered. Papers are solicited in all areas of artificial intelligence in computer-aided design including such areas as:

- **object modelling**
- **graphical reasoning**
- **design knowledge acquisition**
- **case-based design**
- **conceptual design**
- **configuration design**
- **designing with constraints**
- **concurrent design**
- **collaborative design**
- **design analysis**

All papers will be refereed and authors of accepted papers will have the opportunity to revise their papers. Authors should consult Notes for Authors published in the journal for instructions on preparing manuscripts for submission. Three copies of the manuscript should be sent no later than September 16, 1994 to:

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Natural Language Generation at the University of Montréal: Research summary of the SCRIPTUM[1] group

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Résumé

La recherche sur la génération de language naturel á l'université de Montréal à été initiée en 1984 par Richard Kittredge, Guy Lapalme et Michel Boyer. En 1990, une équipe de recherche plus structurée s'est infiltré avec l'equipe de recherche de SCRIPTUM. Cet article décrit les efforts du group SCRIPTUM.

Abstract

Research in natural language generation at the University of Montréal was initiated in 1984 by Richard Kittredge, Guy Lapalme, and Michel Boyer. In 1990, a more structured research team was organized into the SCRIPTUM research team. This document describes the research efforts of the SCRIPTUM group.

From left to right: Michel Gagnon, Nicole Tourigny, Guy LaPalme, Leila Kosseim, Richard Kittredge, Massimo Fasciano (missing from photo are Benoit Lavoie, Daniel Rousseau, Agnes Tutin)

1. Initial Work

In 1984-85, Michel Boyer and Guy Lapalme worked on the generation of paraphrases from semantic networks [3, 5, 6] as defined in Mel'cuk's Meaning-Text theory. The technique used consists primarly in covering the semantic network with trees and to use transformation rules defined in the Meaning-Text theory (for instance, lexical functions) to obtain paraphrases. [7] proposes a summary of this research.

Chantal Contant developed FRANA [8, 9], a French adaptation of ANA, Karen Kukich's stock exchange report generator. This research demonstrated the feasibility and purpose of adapting FRANA's architecture for English to the French language. Indeed, both ANA and FRANA were based on the linguistic studies of "sub-languages" done at the university's linguistic department since 1977 [23] .

In 1986, Richard Kittredge and Alain Polguere developed RAREAS, a generator of meteorological bulletins [29]. This prototype was based on a bilingual generator developed for Environment Canada. This generator is now in operation in three meteorological centers [2].

Stephane Desmarais [10] worked on a question generator for a medical information system; the question series follows a pre-determined decision tree, but the questions generated are influenced by the age and sex of the doctor and the patient, and the relation between the two.

In [19,20], Guy Lapalme presents an overview of logic programming for computational linguistics. One chapter is dedicated to NLG using Prolog's Definite Clause Grammars (DCG).

2. Recently Completed Work

2.1. Tutin: Generating Anaphora in Assembly Instructional Texts

This research is the result of Agnes Tutin's PhD project and Leila Kosseim's master's project supervised by Richard Kittredge and Guy Lapalme.

In order to generate a cohesive text, a NLG system must be capable of producing anaphoric devices. Without them, texts like the following may be produced:

Cut the carrots, the celery and the asparagus. Cook the

carrots, the celery, and the asparagus in boiling water. Take the carrots, the celery, and the asparagus out after 10 minutes.

while the following text is more natural:

Cut the carrots, the celery, and the asparagus. Cook the vegetables in boiling water. Take them out after 10 minutes.

This research investigated the generation of lexical and grammatical anaphora in assembly instructional texts. We have studied the natural introduction of nine anaphoric devices: verbal complement ellipsis, pronominalization, superordination, basic denomination, partial repetition, initial strict repetition, nominalisation, typical result mention, and complex coordination. This was based on a corpus study of 63 cooking recipes (16,000 words).

Given two textual elements A and B, A is an anaphor of B if B is after A in the text, and the referential and/or semantic interpretation of B depends at least partially on A. The generation of anaphora must satisfy three constraints: it must be a "natural" choice rather than an "optimal" one, it should not be ambiguous, and must be lexically valid. To reach this, generation heuristics have been developed taking into account five types of constraints: focus, distance, conceptual, lexical, and ambiguity.

Once the linguistic model was developed, it was implemented into a working system. In order to perform an appropriate lexicalisation, the system takes into account the dynamic aspect of the objects involved in the assembly task: their current state, their creation, and their destruction.

The implementation was done in Prolog using DCG and the feature grammar unifier of Boyer [4]. It takes as input a functional description (FD) representing the "message" to transmit. This FD describes the primitive actions to be performed in the assembly task (for example, to put), then the system converts these primitive actions into more specific concepts (for example, to spread), then finally selects and applies the most appropriate anaphoric device to noun phrases according to the heuristics of the linguistic study.

For more complete descriptions of the work refer to [31, 32, 33, 43, 44]

2.2. Gagnon: Expression of Temporal Localization in a Text Generator

In this project, supervised by Richard Kittredge and Guy Lapalme, we realized a system that takes some description of events happening in the real world, and produces a text which constitutes a good description of the temporal ordering of these events. We have identified that in order to do so, we need to implement two processes. The first one, called structuration, is the translation of the representation of the events given as input into a semantic representation where the same information is expressed, but using one of the multiple perspectives permitted by natural language. The second one, called writing , takes the semantic representation, and produces the corresponding text. In our work, we focused on this second process. As far as the expression of time is concerned, we think that the realization of the structuration process, dealing with rhetorical and pragmatic informations, can be more easily achieved once the mechanisms of language to express time are identified.

We have developed Pretexte, a generator using a method that combines the principles of two theories: the DRT of Kamp and the Systemic Functional Grammar of Halliday. The first one proposes a representation of time taking as primitive the notion of occurrence, that is, facts that take place in time, instead of other notions such as points or intervals. The second provides a generation process controlled by a set of semantic choices, with the syntactic form resulting from these choices.

In French, the temporal localization of occurrences is conveyed mainly by verb phrases (VP) and temporal adverbial phrases (TAP). We propose a semantic representation which enables us to produce TAP and VP independently. We have developed a grammar which covers a large number of the possible syntactic forms, especially for temporal adverbial phrases.

In our system, it appears more clearly what kind of decisions must be done to express temporal localization, and how the different types of information pertaining to this problem could be structured into an implementation. Our implementation shows that DRT and Systemic Grammar can be used successfully to implement the expression of temporal localization. At this moment, we are not aware of any other generator presenting the same expressive power for temporal localization.

For more complete descriptions of the work refer to [12, 13, 14, 15, 16, 17, 18]

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3. Work in Progress

3.1. Kittredge: Rhetorical Relations in Multi-lingual Text Planning

In this work, Mann and Thompson's RST relations are viewed from the viewpoint of their use in planning texts of various types in French and English. For texts in certain technical domains (e.g., weather forecasts, statistical summaries), evidence is found to argue against the use of top-down text planning with RST trees. The cross-serial and other long-distance dependencies in these texts cannot be handled naturally by context-free development of RST plan operators. Other (e.g., context sensitive) uses of rhetorical relations in text planning seem justified, but may be aided by better organizing the distinction between intentional and informational relations. For example, it may be possible to stratify RST relations so that intentional relations are prior in text planning, and informational relations are realizations of them. The particular informational relation (i.e., the "syntactic" means) which best realizes an intentional (i.e., "semantic") relation will then depend on a number of semantic factors in the propositions being related on the intentional level.

For more information, see [30] .

3.2. Kittredge: Linguistic Cohesion and Coherence in Technical Texts

In this research, cohesive relations in text are studied from the viewpoint of planning and realizing instructions in technical sublanguages. The need to express anaphoric relations in these texts gives rise to problems of creating appropriate referring expressions, which satisfy constraints of clarity and economy, while suiting the style of the sublanguage. Recipes and other varieties of assembly instructions have been examined in detail to help identify the factors dictating the choice of particular anaphoric device. Special attention has been given recently to the phenomenon of anaphora via partial repetition of complex noun phrases.

3.3 Fasciano: Integrating Text and Graphics in Statistical Reports

The goal of this research supervised by Guy Lapalme is to produce a tool capable of generating statistical reports which seamlessly integrate text and graphics. Graphics are very effective at giving a global perspective on data. They show a lot of details in a compact and expressive format. On the other hand, text allows readers to focus their attention on the interesting aspects of the data. It allows tendencies to be exposed by refining the analysis. The two forms of expression complement one another very well. Unfortunately, the border between the two is rarely well defined and it must be determined in order to take advantage of their respective strengths.

Our research takes into account the type of statistical variable, which influences the choice of an appropriate graphic and the generated text, and the intent and the perception of the user. Indeed, some graphics are better suited for relations involving continuous variables, whereas others are better suited for discrete variables (line plots are better for continuous data, point plots are better for discrete data). Furthermore, once the type of graphic has been determined, its internal organization is strongly influenced by the type of the variables it describes. For example, when a variable is unordered, we can change the order of appearance of its values in order to emphasize a particular trend in the data. The continuity of variables has an effect on the generated text. Some text simplification techniques can only be applied to continuous data. For example, a duration can be substituted for the beginning and end of an interval.

The problem of the user's intent is crucial in many areas to match the requirements as closely as possible. When the user's intent is unclear (as is the case with exploratory analysis), other data-related criteria must be used to give the reader an acceptable graphic and/or text. The use of exploratory statistics can be very helpful in the extraction of an "interesting message" from the raw data (regression analysis shows correlation between variables). The user's intent has an influence on the global structure of the text. Two texts which illustrate two different messages will not have much in common, whereas two texts based on the same message should have a similar structure (this will be the case for generated texts).

In practice, we see that the "message" is the strongest link between a graphic and its accompanying text. In general, we wish to complement the message expressed through the graphic, so we will usually choose a text based on the same message. When we know the message in advance, the task of selecting a graphic is greatly simplified. Indeed, several studies have identified the relationship between the various kinds of common statistical graphics and the message better suited to each one (pie charts, bar graphs, column graphs, line plots, point plots).

Finally, the graphics we wish to generate are destined for a human reader. Therefore, we must take into account the limitations of human perception. The limitations which are the most interesting to us are linked to the visual system, because it is the one which does most of the decoding when a graphic is involved.

3.4. Kosseim: Planning Instructional Texts for Different Communicative Goals

This project supervised by Richard Kittredge and Guy Lapalme involves the generation of instructional texts (for example, owner's and repair manuals, cooking recipes, ...). Particularly, we are studying how to plan the content of these texts taking into account their communicative goal.

A number of researches have studied instructional texts, but these have always considered that this genre satisfies a unique communicative goal. In this project, we are trying to determine the influence of the communicative goal on the

writing of instructional texts. Following a corpus study, three communicative goals for instructions have been identified. These take into consideration the writer's intentions, the reader's intentions (as perceived by the writer), and contextual factors (the social environment, the situation of the task, and the discourse domain).

For planning instructional texts, we have used Mann and Thompson's rhetorical relations. As instructional texts are well structured, this tool proves to be well suited for the analysis of semantic relations holding between portions of instructional texts. However, in this genre, a single rhetorical relation can carry considerably different informational content. Inversely, a single informational content can be carried by different relations (by a different point of view). For example:

Do A to do B.

Do B by doing A.

These two sentences carry the same informational content namely subordination between two actions, but sentence (1) views the subordination bottom-up and thus uses a relation of purpose, while sentence (2) sees the subordination top-down and uses an enablement.

To account for this mapping, we have created a new intermediate semantic level between informational content and rhetorical relations. This intermediate level allows the selection of semantic carriers before the selection of rhetorical relations. In the project, we investigate the influence of the communicative goal of the instructions first on the selection of semantic carriers from the conceptual representation of the situation (in our case, an action plan), then on the selection of rhetorical relations to present these carriers, and finally, on the grammatical realization of the rhetorical relations. The emphasis of the work is on the selection of semantic carriers for two reasons:

- the communicative goal of instructions influence mainly the planning of the text's content and in previous work, simple and non-corpus based strategies directly map the action plan to the text's contents.
- the selection of rhetorical relations and their grammatical realization are less influenced by the text's communicative goal. Furthermore, this last aspect has already been studied (for the English language).

Once a complete theoretical model has been developed, our goal is to implement these selection heuristics to build a NLG system accepting as input a top level goal (for example, the usage of the fire extinguisher XYZ) and a communicative goal (for example, a case of emergency or a demonstration for an eventual usage) and producing well suited instructions.

3.5. Lavoie: A Study in Text Planning: Application to the Labour Force Summary Sub-domain

This work supervised by Richard Kittredge and Guy Lapalme concerns text planning in the sub-domain of labour force statistical summaries. We are interested globally in the representation of plans and rules guiding content determination and text organization.

Because of the regular forms found in the corpus studied (summaries can be characterized as observing a general-to-particular rhetorical pattern; different summaries have similar macro-structure), and/or graphs are suitable for representing plans; terminal nodes represent conceptual content, while internal nodes can be used to enclose conditions (and rules) for both content determination and content organization.

Determination rules (the most domain-dependent ones) deal mainly with statistical thresholds, allowing the measurement of events' significance.

Organization rules are composed of regrouping rules and ordering rules, and are based principally on the content of the conceptual representations involved. Regrouping rules introduce connectors (and, while, ...) while ordering rules determine anaphoric phenomena.

3.6.Rousseau: Representation and Simulation of Conversations in a Multiagent System

This work, supervised by Guy Lapalme and Bernard Moulin (Département d'informatique, Université Laval), proposes an approach to represent and simulate conversations between autonomous agents considered as intelligent planners that can reason on mental states. This approach takes into account the characteristics of speech acts and conversations. Speech acts are not isolated, but parts of a conversation that may involve two or more agents. They are the best means for an agent to communicate its own mental states, like goals and beliefs, and to affect other agents' ones. They are understandable in the context of a conversation; each speech act is usually related in a certain way to precedent speech acts in a conversation and to agents' mental model. The course of the conversation is dynamic, according to the agent that takes the lead and decides to orient it in some direction. As each locutor agent takes the lead in turn, the structure of a conversation is not established a priori, but during its course. However, each conversation goes through several states.

According to our approach, speech acts are interpreted as exchanges of "conversational objects" (COs) between agents. COs may correspond to goals, beliefs, or other objects relevant for agents like facts, plans, constraints on objects, rules, emotions, interpersonal relationships, etc. The COs are integrated in a conceptual network that is a persistent memory of the conversation accessible by the locutors. This network is a set of COs connected together by some specific relations, like motivations, preconditions, and postconditions.

As a conversation is the result of connected interactions between agents involved in a common goal, we represent and simulate it using a multiagent system composed of locutor agents that take part in conversation, of a conversational agent that manages conversational objects and speech acts performed by locutor agents, and of an environmental agent that simulates the environment in which

agents operate.

Up to now, we have established the theoretical foundations of our approach and identified the different types of COs and relations between COs that are necessary to adequately represent a conversation. To test our approach, we have applied it on several examples of conversations. A multiagent prototype that simulates conversations between agents will be implemented.

3.7.Tourigny: Automatic Generation of Descriptions of Dynamic Systems

This work is supervised by Guy Lapalme. In the field of the generation of text descriptions, many systems deal with static objects but few with the dynamic aspects of a system. However, there are many situations where one could take advantage of a system generating automatically descriptions of dynamic systems. One concrete problem that motivates our research is understanding a dynamic system from its formal specifications and execution traces. It would then be interesting to use a text generator to get a description of it in natural language.

We have developed a text generator to produce some descriptions of a dynamic system in natural language. The starting point of our generation process is the formal specifications and execution traces associated with the system to be described. From these data, a general description of the system is produced in French. Here is an example of a partial description:

Une auto arrive au quai principal ou elle attend un traversier. Ses activités sont ensuite partagées avec cette dernière entité: entrée dans la file, chargement, traversée, déchargement, placement en tête de la file et sortie de la file. puis, elle reprend ses activités propres. Elle livre: elle fait le tour de l'île. Ensuite, elle retourne au quai de l'île ou elle attend un traversier. Un traversier attend: il fait une file d'attente. Il charge: il prend une auto au quai principal, il entre une auto dans la file et il fait le chargement. Il traverse: il fait la traversée. Il decharge: il fait le déchargement, il place une auto a la tête de la file, il sort une auto de la file et il active l'auto. Ensuite, le traversier répète indéfinimiment le chargement, la traversée et le déchargement. Il prend les autos au quai principal et au quai de l'île.

The generator is written in C-Prolog on Macintosh. The specifications of the dynamic system to be described are written in DEMOS, an extension of Simula. See [42] for more information.

4. NLG Papers and Thesis of SCRIPTUM Members

[1] M. Bélanger. Génération intégrée de textes et de graphiques. Technical Report 207, Département d'informatique et de recherche opérationnelle, Université de Montréal, 1990.

[2] L. Bourbeau, D. Carcagno, E. Goldberg, R. Kittredge, and A. Polguere. Bilingual Synthesis of Weather Forecasts in an Operations Environment. In COLING-90, pages 318-320, 1990.

[3] M. Boyer. Génération de phrases à partir de réseaux sémantiques. Technical Report 152, Département d'informatique et de recherche opérationnelle, Université de Montréal, Montréal, May 1984.

[4] M. Boyer. Towards Functional Logic Grammars. In P. Saint-Dizier, editor, Proceedings of the Second International Workshop on Natural Language Understanding and Logic programming, pages 46-62, Vancouver, 1987.

[5] M. Boyer and G. Lapalme. Generating Paraphrases From Meaning-Text Semantic Networks. Computational Intelligence, 1(3), 1985.

[6] M. Boyer and G. Lapalme. Generating Sentences From Semantic Networks. In V. Dahl and P. Saint-Dizier, editors, Natural Language Understanding and Logic Programming. North-Holland, 1985.

[7] M. Boyer and G. Lapalme. Text Generation. In P. Saint-Dizier and S. Szpakowicz, editors, Logic and Logic Grammars for Language Processing, chapter 12, pages 255-274. Ellis Horwood, 1990.

[8] C. Contant. Génération automatique de texte: application au sous-langage boursier francais. Master's thesis, Departement de linguistique et de philologie, Université de Montréal, 1985.

[9] C. Contant. Génération automatique de rapports boursiers français et anglais. Revue québécoise de linguistique, 17(1):197-222, 1988.

[10] S. Desmarais. Génération de questions adaptées à l'usager dans un système de consultation médicale. Master's thesis, Université de Montréal, 1989.

[11] M. Fasciano and G. Lapalme. A Prolog Implementation of the Functional Unification Grammar Formalism. In Proceedings of the Fourth International Workshop on Natural Language Understanding and Logic Programming, pages 37-45, Nara, Japan, September 1993.

[12] M. Gagnon. Expression de concepts temporels en génération automatique de textes. Technical Report 206, Université de Montréal, 1990.

[13] M. Gagnon. Expression de la localisation temporelle dans un générateur de texte. PhD thesis, Département d'informatique et de recherche operationnelle, Université de Montréal, 1993. Publication 888.

[14] M. Gagnon and G. Lapalme. A Text Generator for the Expression of Temporal Expressions. In Proceedings of the Third European Workshop on Natural Language Generation, pages 81-88, Judenstein/Innsbruck, Austria, March 1991.

[15] M. Gagnon and G. Lapalme. Génération de texte: exemple de la production d'un rapport. In Colloque International ICO'91, pages 215-221, Montréal, May 1991.

[16] M. Gagnon and G. Lapalme. Un générateur de texte exprimant des concepts temporels. Technique et science informatiques, 11(2):25-44, 1992.

[17] M. Gagnon and G. Lapalme. From Conceptual Time to

Linguistic Time. Submitted to Computational Linguistics, 1993.
[18] M. Gagnon and G. Lapalme. Pretexte: A Generator for the Expression of Temporal Information. In Proceedings of the Fourth European Workshop on Natural Language Generation, pages 55-65, Pisa, 1993.
[19] A. Gal, G. Lapalme, and P. Saint-Dizier. Prolog pour l'analyse automatique du langage naturel. Eyrolles, 1988.
[20] A. Gal, G. Lapalme, P. Saint-Dizier, and Harold Somers. Prolog for Natural Language Processing. Wiley, 1991.
[21] L. Iordanskaja, M. Kim, R. Kittredge, B. Lavoie, and A. Polguere. Generation of Extended Bilingual Statistical Reports. In Proceedings of the 15th International Conference on Computational Linguistics, pages 1019-1023, Nantes, August 1992. COLING.
[22] L. Iordanskaja, R. Kittredge, and A. Polguere. Lexical Selection and Paraphrase in a Meaning-Text Generation Model. In W. Swartout, C. Paris, and W. Mann, editors, Natural Language Generation in Artificial Intelligence and Computational Linguistics, pages 293-312. Kluwer Academic Publishers, 1991.
[23] R. Kittredge. Semantic Processing of Texts in Restricted Domains. International Journal of Computers and Mathematics, 3(1), 1983.
[24] R. Kittredge. Bilingual Report Generation: Experience with Interlinguae, pages 297-299. Springer-Verlag, 1992.
[25] R. Kittredge, L. Iordanskaja, and A. Polguere. Multilingual text generation and the meaning-text theory. In Proceedings of the 2nd International Conference on Theoretical and Methodological Issues in Machine Translation of Natural Languages. Carnegie-Mellon University, 1988.
[26] R. Kittredge, T. Korelsky, and O. Rambow. On the Need for Domain Communication Knowledge. Computational Intelligence, 7(4):305-314, 1991.
[27] R. Kittredge and A. Polguere. Dependency Grammars for Bilingual Text Generation: Inside FoG's Stratificational Model. In Proceedings of the International Conference on Current Issues in Computational Linguistics, pages 318-330. Penang: University Sains Malaysia, 1991.
[28] R. Kittredge and A. Polguere. Generating Extended Bilingual Texts from Application Knowledge Bases. In Proceedings of the International Workshop on Fundamental Research for the Future Generation of Natural Language Processing, pages 147-160. ATR Interpreting Telephony Research Laboratories, 1991.
[29] R. Kittredge, A. Polguere, and E. Goldberg. Natural Language Report Synthesis: an Application to Marine Weather Forecasts. In Proceedings of the Sixth Canadian Conference on Artificial Intelligence, pages 67-70, Montréal, May 1986.
[30] T. Korelsky and R. Kittredge. Towards stratification of RST. In Proceedings of the ACL Workshop on Intentionality and Structure in Discourse Relations, pages 52-55, Ohio State University, Columbus, Ohio, June 1993.
[31] L. Kosseim. Génération automatique de procédés anaphoriques dans les textes d'assemblage. Master's thesis, Departement d'informatique et de recherche operationnelle, Université de Montréal, 1992.
[32] L. Kosseim and G. Lapalme. Un système de génération d'anaphores dans les textes d'assemblage. Langue Francaise, to be published.
[33] L. Kosseim, A. Tutin, R. Kittredge, and G. Lapalme. Generating Anaphora in Assembly Instruction Texts. In Proceedings of the Fourth European Workshop on Natural Language Generation, Pisa, Italy, April 1993.
[34] G. Lapalme et al. Le projet de génération de texte SCRIPTUM. ICO Intelligence Artificielle et Sciences Cognitives au Quebec, 4(1-2):56-64, 1992.
[35] A. Polguere. Structuration et mise en jeu procédurale d'un modèle linguistique déclaratif dans un cadre de génération de texte. PhD thesis, Departement de linguistique et philologie, Université de Montréal, 1990.
[36] D. Rousseau. Un mécanisme de coopération entre agents: le dialogue. Systèmes. To be published.
[37] D. Rousseau, G. Lapalme,and B. Moulin. A Model of Speech Act Planner adapted to Multiagent Universes. In Proceedings of the ACL Workshop on Intentionality and Structure in Discourse Relations, pages 110-113, Ohio State University, Columbus, Ohio, June 1993.
[38] D. Rousseau, B. Moulin, and G. Lapalme. Modélisation des conversations basée sur une perspective de systèmes multiagents. In Actes du Colloque "Informatique et Langue Naturelle," Université de Nantes, France, December 1993. To be published.
[39] D. Rousseau, B. Moulin, and G. Lapalme. Believable Agents in Conversations. AAAI Workshop on Believable Agents, Stanford University, California, March 1994.
[40] D. Rousseau, B. Moulin, and G. Lapalme. Representation and Simulation of Conversations. AAAI Workshop on Natural Language Understanding in Integrated Systems, Stanford University, California, March 1994.
[41] J.E. Thébault and G. Lapalme. La génération automatique de "cookies." Technical Report 165, Département d'informatique et de recherche opérationnelle, Université de Montréal, August 1985.
[42] N. Tourigny and G. Lapalme. La génération automatique de descriptions de systèmes dynamiques. In ICO-93 Communication des connaissances dans les organisations, pages 283-292. GIRICO, Montréal, mai 1993.
[43] A. Tutin. Etude des anaphores grammaticales et lexicales pour la génération automatique de textes de procédures. PhD thesis, Département de linguistique et philologie, Université de Montréal, 1992.
[44] A. Tutin and R. Kittredge. Lexical Choice in Context: Generating Procedural Texts. In Proceedings of the 15th International Conference on Computational Linguistics, volume II, pages 763-769, Nantes, August 1992. COLING.
[45] A. Tutin, A. Ramos, and G. Lapalme. Use of Explanatory and Combinatory Lexical Functions for Lexicalization in Natural Language Generation. In P. Saint-Dizier, editor, Second Seminar on Computational Lexical Semantics.

Institut de Recherche en Informatique de Toulouse, 1992.

[1] SCRIPTUM means "piece of writing" in Latin and is an acronym for "Système Capable de Reproduire Intelligemment des Phrases et des Textes à l'Université de Montréal" or "Système de Création Informatique de Petits Textes à l'Université de Montréal".

[2] IRO:Département d'informatique et recherche opérationnelle

LP:Département de linguistique et philologie

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IJCAI'95

The 14th International Joint Conference on Artificial Intelligence (IJCAI) will take place in Montreal from August 20 to August 25, 1995.

The Conference is sponsored by the International Joint Conference of Artificial Intelligence Inc. (IJCAI), the American Association for Artificial Intelligence (AAAI) and the Canadian Society for Computational Studies of Intelligence (CSCSI/SCEIO) which will share benefits or losses in the proportion 40%, 40% and 20%. There will be no separate AAAI Conference in 1995. The General Chairman is Ray Perrault from SRI International Program Chairman is Chris Mellish from the University of Edinburgh and the National Chairman is Renato De Mori from Mc Gill University.

The Conference was assigned to Montreal in 1989 during the 11th IJCAI in Detroit which was followed by the 12th IJCAI in Sidney and the 13th IJCAI in Chambery. The 15th IJCAI will take place in Yokohama in 1997. The last IJCAI held in Canada was in 1981 in Vancouver.

The other members of the National Committee are Peter Patel-Schneider (ATT) in charge of liaison with AAAI, Janice Glasgow (Queens) in charge of liaison with CSCSI, Gordon McCalla (Saskatchewan) chair of the tutorial committee, Charles Patrick Sampson (Industry Canada), Gordon Mc Nabb (PRECARN), Jacob Slonim (IBM), Roy Masrani (Alberta Research Council), Garry Lindbergh (Canadian Space Agency), and Jack Brahan (National Research Council).

A poster has been prepared and distribution has started. A sponsor committee has been formed, chaired by Charles Giguere from Concordia University with initial support from the Centre de Recherché en Informatique de Montreal. The program committee has been formed and a call for papers will be out soon. A tentative date for paper submission is January 1995. Notifications of acceptance will be sent March 1995 and papers will be due in April 1995. The topics will be the usual IJCAI topics.

There will be tutorials, workshops, invited speakers, and panels as usual.

AAAI is in charge of the organization. The National Committee will provide local support for the Congress Palace, hotels, transportation, special events organized by the sponsor committee, and will ensure the proper interface with the other committees and sponsoring organizations.

There will be an exhibition of products and books. The Conference on Innovative Applications of Artificial Intelligence (IAAI) will take place at the same time offering the possibility of knowing about the most innovative applications. There will be other special conferences immediately before and after, PRECARN and the Institute for Robotics and Intelligent Systems among them.

IJCAI will be the major international event of the year, bringing together researchers and developers and presenting the best results in theories, techniques and methodologies with the best applications in a large variety of areas, including all branches of engineering, robotics, software production and maintenance, finance and economics, psychology, and medicine.

We expect between 2000 and 3000 participants to this event and we hope it will be of high scientific and industrial significance.

The call for papers is on page 24 of this issue of *Canadian Artificial Intelligence* magazine. The dates in the call for papers are the official ones.

Renato De Mori
National Chairman
IJCAI'95

AI is Alive and Well and Living in Calgary

Penny Rokeby and Connie Bryson

Le département d'ordinateur avancé et d'ingénierie à l'Alberta Research Council rencontre avec grand succès la technologie sur l'intelligence artificielle s'appliquant aux projets industriels et, par le fait même, aidant à avancer l'èconomie en Alberta.

The Alberta Research Council's Advanced Computing & Engineering department is meeting with resounding success applying AI technology to industrial projects, and along the way, is helping to advance the economy of Alberta.

Roy Masrani is feeling a tad grumpy today. Although he isn't usually cranky, Masrani is getting fed up with the doom and gloom, "AI is dead" talk that pervades AI meetings and conferences. His message: AI is alive and well and living in Calgary.

Masrani is a manager in the Alberta Research Council's Advanced Computing and Engineering department located in Calgary. He's been with the department since its inception in 1985 when the staff complement was five. There are now about 30 people in the department, the majority involved in projects that are putting AI to work in industry.

"I go to conferences and I hear all this soul-searching and hand-wringing: 'I can't get funding.' 'AI is dead.' 'Where are the success stories?' "There is no basis for this insecurity. It just doesn't make any sense to me.

"Our business at ARC (Alberta Research Council) runs counter to this. We're having a great time with AI. Companies are using this technology. Here in Calgary we're looking at hundreds of millions of dollars of market potential. We're into AI in a big way."

However the "way" ARC has been into AI has changed over the years. "We went through an evolution," explains Masrani. "We started out with a 'Let's do research in AI' mindset. At that time, it was relatively easy to get a contract to explore AI. The focus was on technology.

"Then we started to get a lot of clients and the emphasis was on applications. Now I'd say our focus is on client satisfaction. We're looking to consolidate our strategic position in terms of applying advanced computing technology.

"We don't have illusions about pushing frontiers. We're looking for solutions to problems. When I go to a company, I don't meet with their R&D group, I meet with a line group. I talk about how advanced computing techniques are different from the standard techniques they're used to, how they can benefit from them, and how we can deliver them."

Delivering the goods

The mission of the advanced computing department, indeed the entire ARC, is to advance the economy of Alberta. One of the reasons for the success of the department is that it has always kept this mission in mind. And the message has struck a responsive chord in industry.

"We're client-focused and have a good grounding in the technology," says department head Ken Gamble. "We're not technology-driven. If a company needs a database, we're not going to build them an expert system. At the same time, however, we do look for companies that have the receptor capacity to use advanced computing technology."

One of those companies is Standen's Ltd., a Calgary-based manufacturer of leaf springs for trucks. The department started working with Standen's in 1987 on a factory automation system. That system, installed in 1988, has allowed Standen's to reduce manufacturing costs, increase production and employment, and compete successfully with spring manufacturers from the Pacific Rim. It was an impressive move into advanced technology for a mature company — Standen's has been in existence for over 60 years — in a mature market.

But the project didn't end with improvements to Standen's own production line. The company is again working with ARC, this time on commercializing the scheduling software used in the plant. Standen's has spun off a company, Smartmaint Systems Inc., to develop the product which is aimed at improving efficiency in all types of manufacturing operations.

The Smartmaint software is part of a revolution in manufacturing that began in the 1960s. Companies are now

using sophisticated software — called "manufacturing resource planning" or MRP programs — to keep constant track of operations in order to save money by reducing overheads and capitalizing on just-in-time delivery. But plant equipment can't run forever, and preventive maintenance is also recognized as an important cost-saving activity.

This issue is often the cause of conflict between the maintenance and the production sides of a manufacturing operation. Taking equipment off-line impacts profitability, but so does waiting until something breaks down. A trade-off has to be made.

Smartmaint software makes that trade-off. Based on an examination of the kind of production under way in a plant, the production schedules and the types of equipment being used, the software determines the optimum time in a production run for preventive maintenance.

The other key feature of Smartmaint is that it interfaces with existing MRP software. None of the maintenance programs now on the market offer this feature. Smartmaint is currently marketing a prototype version of the software, concentrating its efforts on large manufacturers.

Besides manufacturing resource planning, ARC is also working on another hot technology area — enterprise integration. The idea behind enterprise integration is to enable various components to function together, even if they weren't specifically designed to work together. Applied to computing systems, enterprise integration needs an intelligent network to bring diverse information processing activities together regardless of platform, operating system or software application.

New enterprise integration software was unveiled in January by Calgary-based Merak Projects Ltd. and ARC's advanced computing department. HELIOS is a powerful technology that integrates a variety of programs and databases used by the oil and gas sector. Why is integration important? The answer can be found in looking at the operations of any oil company. A typical firm may run software sold by Merak (perhaps its best-selling petroleum economic evaluation program) along with software from other companies and programs created in-house. The company probably also has its own data as well as data bought from commercial suppliers. These are all stand-alone applications; they are not designed to talk to each other.

HELIOS promises not only communication among applications but the establishment of an intelligent network linking applications. For example, an "intelligent agent" built into HELIOS could be used to keep track of revenues and expenses. If expenses exceed revenues by a prescribed amount, the system would e-mail certain company officers right away, thus eliminating the time required to prepare and deliver paper reports.

Estimates from Merak put the sales potential of HELIOS in the Alberta oilpatch at $5-million. The company is gearing HELIOS towards North American and overseas markets. There is also potential for HELIOS to be used in other industries such as manufacturing.

On the move

Another speciality of the advanced computing department is transportation logistics. With close to 400 buses operating across Canada, logistics is a key concern for Greyhound Lines of Canada Ltd. The company must plan to ensure that there are enough buses, and the right kinds of buses, to serve the routes where they are needed most. That requirement brought Greyhound to ARC; the result was an automated fleet planning system called FleetPlanner.

Based on a model of Greyhound's entire Canadian operation (including all arrivals, departures, and maintenance stops), FleetPlanner allows Greyhound's planners to simulate the effects of decisions such as the purchase of new buses and the retrofitting of old ones. At every dispatch point — there are 90 of them — the ARC team put a set of rules, derived from dispatchers, into an expert system that matches buses to trip requirements and flags buses for maintenance if required.

The team also adapted a simulation technique, developed at California State University. Using this method, FleetPlanner can make a decision to move a bus from one city (where it is not required for the foreseeable future) to a city that needs to service a route. If a departure can be serviced from the existing fleet, it reduces idle time and minimizes the need to add more buses to the pool.

"Hurdles to solve like this one made the project fascinating," says Vickitt Lau, one of the ARC team members. "What's really exciting is seeing the potential for FleetPlanner to make a tangible impact on Greyhound's operations."

Optimizing transportation resources is also the focus of a major project under way at ARC now. The advanced computing department is developing a routing and scheduling system for a large Alberta-based company. The technology of choice is genetic algorithms.

"People say that industrial work is boring," notes Masrani. "This project shows how wrong that perception is. We have the opportunity to use a genetic algorithm system, an amazing technique to deal with optimizing huge problems. If that isn't exciting, I don't know what is."

The company will use the software to cut costs and increase market share. But the impact of the technology doesn't stop there. ARC, as co-owner of the intellectual property, plans to commercialize the software.

"It all comes back to our mission — advancing the Alberta economy," Masrani adds. "We're looking for projects that will not only benefit the individual company but have the potential, through commercialization of technology, to open up new markets for Alberta-grown businesses."

It's not only the big projects that can have a major economic impact. One of ARC's small, inexpensive projects has turned out to have great market potential. HERMES

(Heuristic Emergency Management Response Expert System) was developed for a consortium of provincial and federal government departments. The software combines knowledge of the properties of dangerous goods with expertise in the management of chemical spills to provide advice on the management of emergency situations involving dangerous goods. By the fall of this year, Syncrude and the Calgary fire department will have HERMES running in their operations.

"What we've done with HERMES is take a technology, build a business case around it, and then offer it to companies," Masrani explains. "It's all part of the evolution of this department. We're putting the onus on people who are pushing technology to go well beyond saying 'This is neat technology.' They have to wrap it up into a business case complete with applications and markets. HERMES represents that process."

The power of many

Collaboration — the ARC's advanced computing department not only puts collaboration technologies to work in industry, many of its researchers are active collaborators themselves.

Take Marlene Jones and her work on the Intelligent Graphic Interface (IGI) project funded by PRECARN Associates. The five-year $6.8-million project involves 12 participants (companies, research organizations and universities). Its goal is the design of an "expert assistant" for operators of real-time supervisory control systems. The work entails combining advanced computer graphics technology with expert systems and human factors engineering to produce an Intelligent Graphic Interface.

Even before the technical results of the IGI project began to come in, the project generated significant industrial interest because of its unique approach to control room research — work done largely by Marlene Jones' group at ARC in conjunction with researchers at Simon Fraser University.

"This type of research has not been done extensively," Jones explains. "Although we can use some techniques from knowledge engineering, the work we're doing is more comprehensive. We're breaking new ground in both the human factors and user modelling areas."

The team undertook a series of control room studies to look at the problem of supervisory control. Their objective was to determine how the human operators of a control system can influence the operation of the system in the most effective way.

In addition to interest from PRECARN members, a major US telecommunications company and a large process control vendor have approached the IGI team about the control room study methodology. Discussions on how this would be done are now under way.

Jones' work on the IGI project is truly interdisciplinary. It touches on artificial intelligence, graphics, computer-supported cooperative work, human-computer interaction, cognitive psychology, and instructional sciences. "We do so much work that is not technical, there's a running joke around here that we're the 'touchy-feely' group," Jones says.

"But what we do is concern ourselves with the integration of technology into the workplace. The focus is on the users. We look at the barriers to using the technology and ensure that those barriers are addressed. Our goal is finding the right solution for a company, and the technology is only a part of that solution."

The same focus on the user is a key element in another of Jones' projects, the development of computer-based instructional software done with Calgary's Gemini Learning Systems Inc. The software, called SWIFT, was launched in March in Alberta and at various locations throughout Europe.

SWIFT incorporates many features that other training systems do not have. For example, it is an "adaptive learning environment," which means the software is able to modify a course to best fit each person using the system. SWIFT also gives learners feedback based on performance on exercises, rather than simply matching their responses to stored answers as conventional systems do.

Now that the basic framework of SWIFT has been established, work is under way on adding to the system. In particular, the team is incorporating a number of advances coming out of research labs in Canada. One of them is designed to increase motivation. In its current version, SWIFT is geared mainly to technical training and retraining. A typical user is Calgary's Computer Modelling Group which uses SWIFT to teach its reservoir simulation software. In these training situations, the students who use SWIFT tend to be cooperative and motivated.

"The same can't be said for in-school users," says Jones. "We know we have to incorporate a motivational component for the education sector. For this, we'll be building on research done at Simon Fraser University."

Another area targeted for enhancement is SWIFT's diagnostic capabilities. This will involve commercializing research from the University of Saskatchewan. Jones says the improvements in diagnosis and guidance to learners will set SWIFT apart from other products for many years.

"Commercializing these techniques will be a major challenge of the upcoming work," adds Jones. "We do have one advantage, though. We know these state-of-the-art techniques work. This is not speculative research."

An environment view

From the factory floor to the forest floor. Not all advanced computing work at ARC has an industrial focus. Take the Naia project which began in late 1991 as a joint research venture between ARC and Hughes Aircraft of Canada, Spatial Data Systems Division. (Hughes has since dropped out of the project and a number of government agencies and companies have stepped in.) Naia's objective is to develop practical ecological decision support tools for natural resource and environmental management.

The Naia system is object-oriented. It has been designed as a classification shell with the capability to represent uncertainty in a hierarchically structured knowledge base. The classification process implements a combination of symbolic and evidential reasoning and it predicts ecosystems from topography, forest cover, and soil maps. The shell operates in conjunction with a GIS. Polygons are at first interpreted as unspecialized eco-units. As features from different maps become available, this interpretation is gradually specialized into one or more ecoregions or ecosystem associations, each with an associated belief value.

This innovative technology promises substantial cost savings. Manually produced maps cost $5 or more per hectare. Naia system mapping could be accomplished for as little as $1 per hectare. Data from the Naia system is now being compared with map data in a test area covering 5000 hectares near Hinton, Alberta.

The idea for Naia came from the need forestry companies have for ecological decision support tools. The solution required new technology and meant doing basic research. The Naia project is headed by ARC's Jan Mulder. Because he is also an adjunct professor at the University of Calgary, Mulder is uniquely qualified to do this type of research.

"I'm very interested in theoretical work, but also in making it marketable," Mulder says. "This project represents a different vision of research — a practical problem that needs resolution by doing fundamental work. No theory is instantly and perfectly fit for practical application. Naia is a good example of interesting theoretical research done on a practical problem."

International connections

While ARC's business focus is on Alberta, its hunt for technology is worldwide in scope. For the advanced manufacturing area, this means being part of an international effort aimed at developing the automated factories of the next century. The Intelligent Manufacturing Systems (IMS) consortium involves 140 partners — companies, research institutes and universities in Canada, Japan, the United States, Australia, and the European Economic Area.

The consortium was formed in 1993 and has since undertaken six test cases which deal with specific aspects of manufacturing such as robotics, concurrent engineering, and process industries. These projects will run until March 1994 when they will be evaluated and decisions made about continuing them for the next 10 years.

A group from the advanced computing department is a regional coordinating partner for the knowledge systematization test case. Called Gnosis (the Greek word for knowledge), this project also involves the University of Calgary and international partners such as Mitsubishi Electric Corporation, the Fraunhofer Institute, IBM France, and Telemechanique France.

The Gnosis project team is investigating the incorporation of knowledge — about the environment, customers, and products — into next-generation production systems. These new systems represent a major shift in design from the current mass-production manufacturing systems. The knowledge-based systems will take into account issues such as environmental degradation, global economy, depletion of resources, and re-configuration and reusability.

ARC's Aldo Dagnino has been working with the IMS consortium since its inception. He sees technology transfer to Alberta industry as the main benefit of IMS involvement. In fact, the advanced computing department has already used one of the tools from the Gnosis test case in a project done with an Alberta company. It involves developing a plant reconfiguration system for EDO Canada, a Calgary-based aerospace company. The system will provide a real-time analysis of resources based on production requirements.

"Through the IMS consortium, we have open access to three types of work: precompetitive research, which is usually done in universities and is very hard to access; applied research, which is done mainly in research institutes; and research done in-house by the participating corporations," explains Dagnino.

"It would have been very difficult, perhaps impossible, to have this kind of worldwide access to information in the absence of the consortium. And now we're able to bring these tools and ideas to Alberta industry. It is ARC's role to disseminate this information and evaluate how it can be applied in industry."

What's next?

Don't look for hand-wringing or listen for doom-saying about the future of AI in Calgary. This is an upbeat crowd, one that's buoyed not by hot air but by a solid reputation for delivering advanced computing solutions that work. It's this "people power" that department head Ken Gamble intends to capitalize on.

"We're still evolving, looking for better ways to stay current with the sheer volume of technological change," Gamble says. "We're also trying to look at more integrated solutions. One of our aims is search for new ways of process re-engineering, for example using genetic algorithms.

"It's an interesting mix of people we have here. They are excited by the technology, they are innovative and scientifically minded, and they can focus on client needs. Technology management really isn't so much about technology or some abstract process, it's people-based. We've found it comes down to people working well together. Finding the balance is important. There's no algorithm for that."

Penny Rokeby *makes her home in Calgary, Alberta. Her works have appeared in a diversity of publications, including Canadian Artificial Intelligence magazine.*

Connie Bryson *lives in Edmonton, Alberta and is a frequent contributor to Canadian Artificial Intelligence magazine.*

Call for papers

IJCAI-95

Fourteenth International Joint Conference on

The biennial IJCAI conferences are the major forums for the international scientific exchange and presentation of AI research. IJCAI'95 is sponsored by the International Joint Conference of Artificial Intelligence Inc. (IJCAI), the American Association for Artificial Intelligence (AAAI), and the Canadian Society for Computational Studies of Intelligence (CSCSI/SCEIO).

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Jack Brahan, National Research Council

Topics of Interest
Submissions are invited on substantial, original, and previously unpublished research in all aspects of AI, including, but not limited to:

Architectures and languages for AI (e.g., parallel hardware and software for building AI systems)
Artistic, entertainment, and multimedia applications.
Automated reasoning (e.g., theorem proving, abduction, automatic programming, search, context management and truth maintenance systems, constraint satisfaction, satisfiability checking)
Cognitive modeling (e.g., user models, memory models)
Connectionist and PDP models
Distributed AI, autonomous agents, multi-agent systems, and real-time issues.
Intelligent teaching systems
Knowledge Engineering and Principles of AI applications (e.g., for design, manufacturing control, grand challenge applications)
Knowledge representation (e.g., logics for knowledge, action, belief and intention, nonmonotonic formalisms, complexity analysis, languages, and systems for representing knowledge)
Learning, knowledge acquisition, and case-based reasoning
Logic programming (e.g., semantics, deductive databases, relationships to AI knowledge representation)
Natural language (e.g., syntax, semantics, discourse, speech recognition and understanding, natural language front ends, generation systems, information extraction and retrieval)
Philosophical foundations
Planning and reasoning about action (including the relation between planning and control)
Qualitative reasoning and naive physics (e.g., temporal and spatial reasoning, model-based reasoning, diagnosis)
Reasoning under uncertainty (including fuzzy logic and fuzzy control)
Robotic and artificial life systems (e.g., unmanned vehicles, vision/manipulation systems)
Social, economic, and legal implications
Vision (e.g., color, shape, stereo, motion, object recognition, active vision, model-based vision, vision architectures and hardware, biological modeling).

Palais des Congrès de Montreal
Montreal, Quebec, Canada

Artificial Intelligence •August 20-25, 1995

Other Calls
Calls for tutorial and workshop proposals and video presentations for IJCAI-95 will be issued shortly.

Timetable
Submissions must be received by **January 6th, 1995.** Submissions received after that date will be returned unopened. Authors should note that ordinary mail can sometimes be considerably delayed, especially over the new year period, and should take this into account when timing their submissions. Notification of receipt will be mailed to the first author (or designated author) soon after receipt.

Notification of acceptance or rejection: successful authors will be notified on or before March 20th, 1995. Unsuccessful authors will be notified by March 27th, 1995. Notification will be sent to the first author (or designated author).

Camera ready copies of the final versions of accepted papers must be received by the publisher in the USA by April 24th, 1995.

Note that at least one author of each accepted paper is required to attend the conference to present the work.

General
Authors should submit six (6) copies of their papers in hard copy form. All paper submissions should be to the following address. Electronic or fax submissions cannot be accepted.

IJCAI-95 Paper Submissions
American Association for Artificial Intelligence
445, Burgess Drive
Menlo Park, CA. 94025, USA.
(Telephone (415) 328-3123, Email ijcai@aaai.org)

Appearance and Length
Papers should be printed on 8.5" x 11" or A4 sized paper. They must be a maximum of 15 pages long, each page having no more than 43 lines, lines being at most 140 mm long and with 12 point type. Title, abstract, figures, and references must be included within this length limit. Papers breaking these rules will not be considered for presentation at the conference.

Letter quality print is required. (Normally, dot-matrix printout will be unacceptable unless truly of letter quality. Exceptions will be made for submissions from countries where high quality printers are not widely available.)

Title Page
Each copy of the paper must include a title page, separate from the body of the paper. This should contain:

- Title of the paper
- Full names, postal addresses, phone numbers, fax numbers, and Email addresses (where these exist) of all authors. The first postal address should be one that is suitable for delivery of items by courier service.
- An abstract of 100-200 words
- A set of keywords giving the area/sub-area of the paper and describing the topic of the paper. This information, together with the title of the paper, will be the main information used in allocating reviewers.
- The following declaration: "This paper has not already been accepted by and is not currently under review for a journal or another conference. Nor will it be submitted for such during IJCAI's review period.''

Policy on Multiple Submissions
IJCAI will not accept any paper which, at the time of submission, is under review for a journal or another conference. Authors are also expected not to submit their papers elsewhere during IJCAI's review period. These restrictions apply only to journals and conferences, not to workshops and similar specialized presentations with a limited audience.

Review Criteria
Papers will be subject to peer review, but this review will not be "blind" (that is, the reviewers will be aware of the names of the authors). Selection criteria include accuracy and originality of ideas, clarity, significance of results and the quality of the presentation. The decision of the Program Committee, taking into consideration the individual reviews, will be final and cannot be appealed. Papers selected will be scheduled for presentation and will be printed in the proceedings. Authors of accepted papers, or their representatives, are expected to present their papers at the conference.

Distinguished Paper Awards
The Program Committee will distinguish one or more papers of exceptional quality for special awards. This decision will in no way depend on whether the authors choose to enhance their paper with a video presentation.

AI/GI/VI'94

Workshops

Distributed A I - Monday, May 16, 8:30 to 5:00
The purpose of this workshop is to bring together, within a rather informal forum, active researchers in the field of Distributed Artificial Intelligence (DAI). The aim is to generate a greater awareness and stimulate Canadian involvement in this emerging field of research. Through presentations and discussions, the participants will exchange, compare, and contrast results and positions on related issues. The format will provide ample time for discussions and exchange of ideas. Presentations will concern all areas of Distributed Problem Solving and Multi-Agent systems.

For more information contact:
Denis Gagne
College militaire royal, Richelain, Quebec J0J 1R0
Ph: 514-358-6752 Fax: 514-358-6799 email:
dgagne@cmr.ca

Machine Learning - Tuesday, May 17, 8:30 to 5:00
The purpose of this workshop is to bring together people who are active in applications or (theoretical or experimental) studies of machine learning. Participants in related fields such as computational studies of human learning, genetic algorithms and neural nets are also welcome. The emphasis of the workshop will be on informal communication and exchange of ideas.

For more information contact:
Bruce MacDonald
Computer Science Department, University of Calgary
2500 University Drive NW, Calgary, Alberta T2N 1N4
Ph: 403-220-5112 Fax: 403-284-4707
email: bruce@cpsc.ucalgary.ca

Programming Paradigms for AI - Tuesday, May 17 8:30 to 5:00
Logic, functional, object-oriented paradigms, and others, have sprung from the desire to make the task of programming more akin to a specifically human endeavour as opposed to what machines expect. This workshop aims at providing a perspective of the state of the art in programming paradigms for AI and for expressing complex knowledge in general. Topics of focus include, but are not limited to: (a) Logic vs. functional vs. other paradigms. (b) How close are we to declarative programming? and (c) Should the competing approaches be merged, and if so how can this be done? The intended audience includes researchers implementing AI systems and studying language support for knowledge representation.

For more information contact:
Fred Popowich
School of Computing Science, Simon Fraser University
Burnaby, BC V5A 1S6
Ph: 604-291-4193 Fax: 604-291-3045
e-mail: popowich@cs.sfu.ca

Image Processing with Khoros - Tuesday, May 17 8:30 to 12:00
Gregory W Donohoe, University of New Mexico
Khoros is a portable software application environment that is especially well suited to image processing. Originally developed at the University of New Mexico, Khoros is available free to end users. There are between 10,000 and 20,000 users worldwide. Khoros is easily extensible; about a dozen toolboxes and 100 image processing routines have been contributed by researchers in Europe, Asia and North and South America. Like Khoros itself, these are available free over the Internet by anonymous ftp. This workshop will present an overview of Khoros and illustrate how applications are constructed.

Evolutionary Algorithms - Tuesday, May 17 1:30 to 5:00
Gerhard Roth, National Research Council
Evolutionary algorithms (EA) are powerful methods for solving various search and optimization problems. The EA field includes such diverse approaches as genetic alogrithms (GA), evolutionary programming (EP), Classifier systems (CFS) and genetic programming (GP). All of these different approaches are based on principles from the theory of evolution. We will discuss applications of each approach for practical problems in such diverse areas as scheduling, image processing, and engineering design. Some commonly available public domain EA software packages will be surveyed.

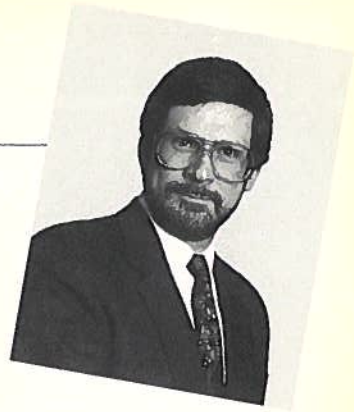
For more information for Image Processing & Evolutionary Algorithms Workshops contact:
Colin Archibald
National Research Council of Canada, Montreal Road
Ottawa, Ontario K1A 0R6
Ph: 613-993-6580 Fax: 613-952-0215
email: archibald@iit.nrc.ca

Please Note: Workshop Fees are the responsibility of individual workshops.

To register for the above workshops, please contact the person listed with that workshop.

PRECARN UPDATE
NOUVELLES DE PRECARN

Jean-Claude Gavrel



Four New PERKs are Approved

PRECARN's newest program, the Program for the Exploitation of Research Knowledge (PERK) has acquired four new research projects, totaling funding of $3.6 million - and they're ready to go!

The projects are aimed at transferring research results of longer-term innovative research projects into proof-of-concept prototypes for industrial applications. Thirteen of PRECARN's member companies will participate in this initial round.

With this new program, PRECARN is complementing its current long-term research activities in robotics and intelligent systems and encouraging Canadian companies to work collaboratively in the development and pre-commercialization of new technologies. These projects are expected to develop technologies that will lead to new products or processes and thus help the competitive position of the industrial partners. The four new PERK projects are:

VisiWall: Intelligent Visualization on Large-Scale Displays *B.C. Hydro, M3i Systems Inc., and MPR Teltech Ltd.*

The VisiWall project will design, develop, evaluate and demonstrate a proof-of-concept prototype software system that combines the results of new research conducted by the IGI project (a PRECARN project) in the area of intelligent visualization with X-WALL, an innovative product recently developed by M3i Systems Inc. of Montreal.

Semi-autonomous Robotic Surface Vehicle for Industrial and Military Applications *Syncrude Canada, Defence Research Establishment Suffield, and Alberta Research Council*

This project will develop a robotic truck system that will perform hauling functions in a commercial surface mine through a combination of autonomous and teleoperated activities. The primary objective of the project is to develop a semiautonomous vehicle system that can independently navigate across outdoor terrain and avoid obstacles.

Parallel Spatial Analysis and Interactive Visualization Software *ATS Aerospace, Centre de recherché informatique de Montreal, and Defence Research Establishment Valcartier*

This project is aimed at developing open software tools capable of exploiting a scalable range of high performance parallel computers for spatial-based analysis and interactive visualization of terrain information such that the tools can easily be integrated within existing and future spatial information systems.

Range-Vision for Telerobotic Control in Hazardous Environments *Atomic Energy of Canada Limited, Spar Aerospace Limited, National Research Council, and Canadian Space Agency*

The objective of the project will be to demonstrate and test strategies for the remote operation of robotic manipulators using range vision to perform work in unstructured environments. The proposed proof-of-concept delivery system provides a platform for evaluating next-generation prototype tools and control methods prior to field trials.

PRECARN Continues its Efforts to Attract Small Business

As technologies begin to emerge from PRECARN's research projects, it becomes obvious that small Canadian companies (defined as more than five and fewer than fifty employees) can play a major role in getting these technologies to market. Some of our most innovative and successful products have been developed in home basements or in small company establishments. To capitalize on that expertise, PRECARN has initiated two programs to encourage small companies to participate in its research programs.

The first program invites small companies to participate directly in research projects through sub-contracts. This policy, set in late-1992, encourages leaders of newly-launched projects to set aside at least 5% of their total budget to sub-contracts with small Canadian companies.

The second initiative, approved by the Board of Directors in December 1993, offers more global participation by small business. In recognizing the special needs and budgetary constraints of small companies, PRECARN is launching a "Subscription Service," aimed at keeping small companies

current on all of PRECARN's programs. The new service, to be implemented in the spring, includes invitations to workshops and conferences as well as access to publications, reports, and technology disclosures. By taking advantage of these venues, small companies will be well-positioned to pick up the technology and take it to market. Having first-hand access to the experts in other companies and universities will, no doubt, be very beneficial to many Canadian small business entrepreneurs.

Workshop Success Continues

Bring eighty people together, demonstrate your work, and present up-to-date technologies and what do you end up with? A very successful workshop. PRECARN's Telerobotics Development System (TDS) team held such a workshop in November 1993. The one-day event, held at the offices of MPB Technologies in Dorval, Quebec, brought in telerobotics experts working on the project to discuss their work with industry, university, and government representatives.

Presentations, hands-on demonstrations, and some very exciting advances in telerobotics were shown. Delegates even had the opportunity to try on a Helmet-Mounted Display unit - a head tracker assembly which followed the operator's head, with two twin cameras looking in the same direction.

At the time of writing, preparations were underway for another workshop, the March 3-4 workshop of the APACS project (Advanced Process Analysis and Control System) hosted by CAE Electronics in Montreal. The workshop aims at demonstrating the power of APACS in monitoring industrial processes such as a feedwater system in order to detect and diagnose failures. The APACS framework architecture has been designed to accommodate a large variety of industrial processes and is already attracting attention from potential customers. Two other workshops are planned for later this year, from the Intelligent Graphic Interface Project (IGI) and from the Autonomous Robot for a known Environment (ARK) project.

Gearing Up for Our Biggest Event

The presses have been working overtime getting ready for our fourth annual IRIS/PRECARN Conference. This year, over 400 university, industry, and government representatives will meet in Toronto from June 21st to the 23rd. As the Institute for Robotics and Intelligent Systems (IRIS), the federal Network of Centres of Excellence managed by PRECARN, draws to a close, participants will report on their achievements and successes - and focus on technologies emerging from their research projects.

Once again this year, highlights of the Conference will include demonstrations and videos of the research projects within IRIS and PRECARN, and the presentation of student posters. Last year, close to 100 students participated in the contest, vying for three prizes.

As noted earlier, PRECARN has initiated steps to encourage participation of non-member companies. With the focus on technologies emerging from the IRIS program, there is no better forum for small companies to learn about the latest advancements in intelligent systems, and how they can profit from these advancements.

Those interested in obtaining more information on the PRECARN/IRIS networks, and on attending this year's Conference, may contact Mrs. Lise McCourt, Manager of Corporate and Public Relations at the following address:

PRECARN Associates Inc.
300-30 Colonnade Road, Nepean, Ontario K2E 7J6
Tel: (613) 727-9576 Fax: (613) 727-5672
E-mail: gavrel@a1.atott2.nrc.ca

BOOK REVIEWS

Foundations of knowledge acquisition: Cognitive models of complex learning *Susan Chipman and Alan L. Meyrowitz (editors)* (Office of Naval Research and Naval Research Laboratory) Boston: Kluwer Academic Publishers (The Kluwer international series in engineering and computer science: Office of Naval Research advanced book series, edited by André M. van Tilborg), 1993, x+339 pp; hardbound, ISBN 0-7923-9277-9, US$79.95

Reviewed by
Jean-François Delannoy
University of Ottawa

The book reflects the work done in the past five years in an Accelerated Research Initiative of the Office of Naval Research. This volume is the first of two books on acquisition — the other deals with machine learning. Four of the nine chapters were written by psychologists, three by computer scientists, and two are collaborations. The chapters follow a general ordering from the applied to the abstract. Over a half of them present case studies on domains ranging from electronic circuit design and LISP proficiency to the solving of mathematical problems. There are three reviews of the state of the art (on planning, knowledge revision, and natural language processing), and presentations of new systems or techniques for acquisition.

K. VanLehn and R.M. Jones, in "Learning by explaining examples to oneself: A computational model," start from the observation of how proficient students learn a new domain: one noted characteristic is the capacity for "self-explanation," by which a good learner explains to himself the examples (and thus abstracts them) and needs less complete reference to them for later solving. The aim of the simulation programme, Cascade, is to reproduce the rediscovery of rules of physics, and to gain increasing reasoning competence. An experiment is described in which Cascade models the acquisition of rules of physics.

S. Ohlsson discusses the role of prior knowledge in the detection and resolution of contradiction in automatic learning; when the 'Heuristic Searcher' algorithm finds a rule violating a constraint, it regresses in two ways: to a rule in which the constraint is irrelevant, and to a rule in which the constraint is relevant and satisfied. The author examines the central role of prior knowledge in controlling the search for the appropriate rules. S. Huffman, D. Pearson, and J. Laird also discuss the question of knowledge revision in a good overview of the state of the art.

J. Hammond gives a survey of research on case-based planning. J. Anderson and A. Corbett apply ACT*, Anderson's classical model of human reasoning (Anderson 1983), to the acquisition of LISP skills. D. Kieras has an applicative chapter on cognition and ergonomy of the learning of electronics. S. Marshall discusses the first stages of learning a new topic, and stresses the importance of the first example, upon which the learner elaborates his construction of the field. P. Rosenbloom, S. Lee, and A. Unruh study variants of planners implemented in SOAR, which differ in their use of goal flexibility (rejection of a plan, or local use of sub-goals) or goal protection; a comparative discussion with biases in explanation-based learning follows.

R. Wilensky's contribution, "Knowledge acquisition and natural language processing," presents elements of the system MANDI, a text skimmer — used by the UNIX Consultant on-line help tool — which acquires knowledge about UNIX from manuals by combining shallow linguistic knowledge and its current knowledge of UNIX. Then he discusses some aspects of acquisition from machine-readable dictionaries and text corpora, somehow superficially if compared with the overview of knowledge revision by Huffman et al. in the same volume. Discussions with a larger scope can be found in recent issues of *Artificial Intelligence* and *Computational Linguistics.*

Discussion

The term 'foundations' in the title is taken in two senses: one is the study, applied or more theoretical, of human learning for acquisition, in view of a fundamental grounding for the field; the other is the design of paradigmatic approaches. Those two aspects are combined in both of the chapters I liked most, those by Huffman and by VanLehn and Jones.

The volume is up to date, but too strictly American; even if, due to the funding pattern of the research initiative, the authorship reflects the work of a U.S. group, its scope of interest and references could have been less geographically monochrome. Maybe the more applicative second volume will go such a long way as mentioning the Banff acquisition workshop, for example.

Both Wilensky and VanLehn stress the importance of acquisition from natural language text, a point already made, among others, by Tom Dietterich in a keynote address of the

1990 Machine Learning Conference. In practice, the problem is often addressed from one side only; some teams are working either on tools for processing pre-encoded text or apply only shallow analysis, while other teams are developing strictly linguistic tools to process texts, dictionaries or corpora, with the goals of acquiring general knowledge or linguistic knowledge itself (Powers and Turk 1989). A tighter combination is found in systems like SCISOR and PUNDIT (see the articles by P. Jacobs and L. Rau and by M. Palmer et al. in the special issue of *Artificial Intellgence* 1993). MaLTe (Delannoy et al. 1993) is an even more integrated acquisition system in which background knowledge is derived from thorough text analysis, and machine learning allows generalization of examples and the addition of missing reasoning links via lazy user interaction, instead of using pre-encoded knowledge.

I wondered whether a discussion on non-symbolic approaches had its place in such a book — probably not; the buyer or reader will know at a glance that it deals with symbolic methods, and contrastive or polemical discussions can be found elsewhere easily. As for machine learning, which is only hinted at here, it is the central theme of the second volume. So the nine chapters, as the corresponding lines of the choice of teams elected to participate in the Accelerated Research Initiative, represent a rather good coverage of the domain.

Overall, the book is of good quality by the technical level and the variety of topics and approaches. Together with the second volume on machine learning (yet to appear), it will make a good and informative package to have at hand.

References

Anderson, J.R. *The Architecture of Cognition* Cambridge University Press, 1983.

Computational Linguistics, special issue on using large corpora, 19(1-2), 1993.

Delannoy, J.F., Feng, C., Matwin, S., and Szpakowicz, S., "Knowledge extraction from text: Machine learning for text-to-rule translation." Proceedings of the Machine Learning and Text Analysis Workshop, ECML-93, Vienna, pp. 1-7., 1993

Artificial Intelligence (Special Issue on Natural Language Processing), 63(1-2), October 1993.

Powers, D.M. and Turk, C.R. *Machine Learning of Natural Language* Springer Verlag, 1989.

Jean-François Delannoy *is a postdoctoral fellow at the University of Ottawa. He holds a doctorate from the University of Marseilles, France, and has been working in natural language semantics and linguistic applications of machine learning. His interests are computational linguistics, knowledge representation and acquisition, and application of AI in the arts.*

The engineering of knowledge-based systems: Theory and practice *Avelino J. Gonzalez and Douglas D. Dankel* University of Central Florida and University of Florida) Englewood Cliffs, NJ: Prentice-Hall (an Alan R. Apt book), 1993, xx+523 pp and two 5.25" diskettes for MS-DOS; hardbound, ISBN 0-13-276940-9, no price listed

Reviewed by
John Mylopoulos
University of Toronto

The objective of this book is to serve as an introductory textbook for the topic of knowledge-based systems. The book has two main sections, one offering an introduction to knowledge based systems (the "Theory" part of the book title) while the other focuses on their development (the "Practice" part).

Under "Theory," the book covers topics such as knowledge-based system structure, logic and automated reasoning (including a short introduction to Prolog), rule-based systems, semantic nets, frames and objects, and uncertainty management. Chapter titles in the "Practice" section include the knowledge-based system life cycle, feasibility analysis, requirements specification, knowledge acquisition, and verification and validation of knowledge based systems. Each chapter includes a summary and exercises for the student. In addition, the book contains two appendices that introduce the CLIPS system, a popular public-domain expert-system shell, and the Personal Consultant Plus Shell System. A copy of CLIPS and a demonstration of Personal Consultant Plus come on floppies with the book. These are perhaps its best features.

In addition to the material, and the floppies, the book is noteworthy for the breadth of its coverage. In it, the reader will find anything from a brief introduction to Prolog to material on fuzzy logic, temporal reasoning, and case-based reasoning. Because of this breadth, the book may be a good first source of information for non-computer scientists who wish to get quick introductions on a number of topics related to knowledge-based systems.

The book's breadth also means that its treatment of different topics is rather shallow. For example, the concept of unification associated with the resolution principle and the algorithm for finding the most general unifier for a given set of terms is at best superficial, relying mostly on examples. Likewise, the discussion on the knowledge-based system life cycle, several chapters later, is based on standard material found in any textbook on systems analysis and design, with some discussion on how knowledge-based systems differ from conventional software. This discussion too is by-and-large superficial. For instance, the claim that "software engineering involves representing well-known and well-

defined algorithmic procedures" doesn't stand up for important classes of "conventional" software, such as information systems, where often there are no procedures to start with, let alone "well-known and well-defined" ones.

Another reason why the book is weak as a potential textbook is that it makes very few assumptions about the reader's background, thereby necessitating introductions on topics such as propositional logic and Prolog. On the other hand, the book does include Lisp code, in sections declared as optional for the first-time reader. On this issue, it may have been preferable for the book to assume that its reader has working knowledge of Lisp, Prolog, and mathematical logic, thereby narrowing the book's scope.

Because of these features, this book is best suited for non-computer scientists who are interested in building a knowledge-based system and want to get a quick introduction of the concepts and the practice of knowledge-based systems so that they can get started. The book would not be appropriate for computer science students who want to take an advanced undergraduate course on the subject.

John Mylopoulos *performs research in knowledge-based systems at the University of Toronto. In 1992, he received the CSCSI Distinguished Service Award.*

BOOKS RECEIVED

Reviewers are sought for books marked with a * in the list below. Readers who wish to review books for *Canadian Artificial Intelligence* should write, outlining their qualifications, to the book review editor, Graeme Hirst, Department of Computer Science, University of Toronto, Toronto, Canada M5S 1A4, or send electronic mail to gh@cs.toronto.edu or gh@cs.utoronto.ca. Obviously, we cannot promise the availability of books in anyone's exact area of interest.

Authors and publishers who wish their books to be considered for review in *Canadian Artificial Intelligence* should send a copy to the book review editor at the address above. All books received will be listed, but not all can be reviewed.

Challenges in natural language processing *Madeleine Bates and Ralph M. Weischedel (editors)* (BBN Systems and Technologies) Cambridge, England: Cambridge University Press (Studies in natural language processing, edited by Branimir K. Boguraev), 1993, xi+296 pp; hardbound, ISBN 0-521-41015-0, US$49.95

*** Associative engines: Connectionism, concepts, and representational change** *Andy Clark* (University of Sussex) Cambridge, MA: The MIT Press, 1993, xiii+252 pp; hardbound, ISBN 0-262-03210-4, US$29.95

Computers in context: The philosophy and practice of systems design *Bo Dahlbom and Lars Mathiassen* (Chalmers University of Technology and Aalborg University Centre) Cambridge, MA and Oxford: NCC Blackwell, 1993, x+306 pp; hardbound, ISBN 1-55786-430-6, US$49.95

*** Scheduling of production processes** *Jürgen Dorn and Karl A. Froeschl* (Technical University of Vienna) Chichester: Ellis Horwood (Ellis Horword series in artificial intelligence),1993, xiii+181 pp; hardbound, ISBN 0-13-075136-7, no price listed

*** Representing uncertain knowledge: An artificial intelligence approach** *Paul Krause and Dominic Clark* (Imperial Cancer Research Fund, London) Oxford: Intellect Books and Dordrecht: Kluwer Academic Publishers, 1993, ix+277 pp; hardbound, ISBN 0-7923-2433-1, no price listed; paperbound, ISBN 1-871516-17-X, 14.95 pounds

The functional treatment of parsing *René Leermakers* (Institute for Perception Research, Eindhoven) Dordrecht: Kluwer Academic Publishers (The Kluwer international series in engineering and computer science; Natural language processing and machine translation, edited by Jaime Carbonell, volume 242), 1993, xvi+158 pp; hardbound, ISBN 0-7923-9376-7, US$79.95

Intelligent multimedia interfaces *Mark T. Maybury (editor)* (MITRE Corporation) Menlo Park, CA: AAAI Press and Cambridge, MA: The MIT Press, 1993, vi+405 pp; paperbound, ISBN 0-262-63150-4, US$39.95

The new hacker's dictionary (second edition) *Eric S. Raymond (compiler)* Cambridge, MA: The MIT Press, 1994, xxi+505 pp; paperbound, ISBN 0-262-68079-3, US$14.95

Goal-based decision making: An interpersonal model *Stephen Slade* (New York University) Hillsdale, NJ: Lawrence Erlbaum Associates, 1994, xiv+285 pp; hardbound, ISBN 0-8058-1366-7, US$59.95

Constraints on language acquisition: Studies of atypical children *Helen Tager-Flusberg (editor)* (University of Massachusetts) Hillsdale, NJ: Lawrence Erlbaum Associates, 1994, viii+228 pp; hardbound, ISBN 0-8058-0667-9, US$49.95

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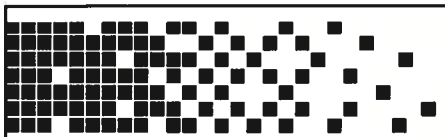
*Includes Applicable G.S.T.



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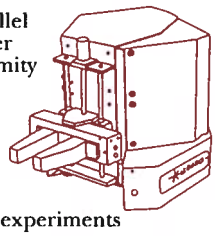
Thanks for your Leadership

Intelligent Micro-Robots

for Industrial Robot Prototyping and *ALife* Experiments

R-2

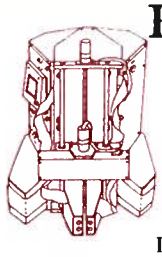
Compact, Integrated, Wheeled Micro-Robot



- Vertical direction parallel mechanical jaw gripper
- Ring of infrared proximity & bump sensors
- Cartesian manipulator for exploration
- Ideal for autonomous interaction, ALife, autonomous factory, and cooperative work experiments

R2E

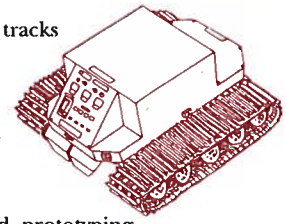
Extended R-2 System (all features of R2 apply)



- New 32-bit P2 processor, based on the Motorola 68332, configured on Vesta board.
- 1 Mbyte SRAM
- 32 Kbytes EPROM including R2 operating system.
- Graphic programming and monitoring environment.
- Ideal for prototyping advanced intelligent mobile robots for industrial applications and ALife experiments.

T-1

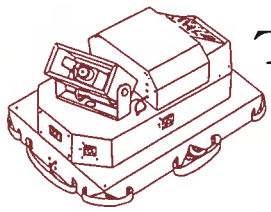
Highly Maneuverable Tracked Intelligent Micro-Robot Platform



- High power caterpillar tracks for rugged terrain
- Low or high gear ratio option
- Infrared sensors for collision avoidance
- Piezo-electric bump sensors
- Ideal for mixed terrain cooperative studies and prototyping autonomous civil engineering equipment

T-2

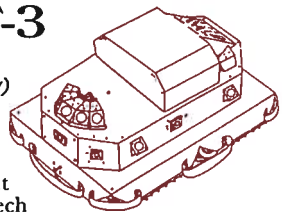
T-1 Based Tracked Exploration Robot (all features of T-1 apply)



- Color video camera and video transmitter (base receiving station included).
- Radio command/data link.
- Optional IR proximity sensors.
- Ideal for mixed terrain cooperative exploration.
- Adapted by NASA for lunar surface exploration.

T-3

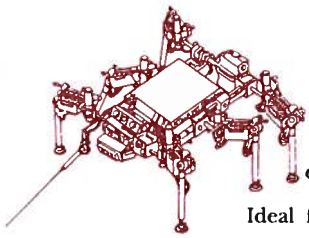
T-1 Based Tracked Human/Animal Interaction System (all features of T-1 apply)



- Pyro sensors for detecting human (animal) presence
- Light sensors to detect light intensity and gradient
- Optional microphones, speech recognition board, and digital speech output board
- Ideal for surveillance systems, entertainment systems, and intelligent toy

Attila-II

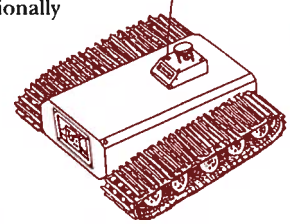
Highly Dexterous Six-Legged Micro-Robot



- Equipped with 150 high performance sensors.
- Gyro stabilized CCD camera and rangefinder.
- High performance multi-processor network.
- Capable of determining environmental lay, texture, hardness and color.
- Ideal for exploration, inspection and sample collection.
- Adapted by NASA for planetary exploration.

Pebbles

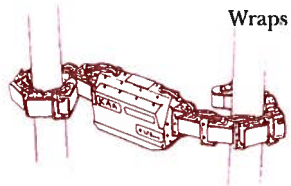
Sealed Tracked Robot for Hazardous Environments



- Large payload capacity and expandability in the chassis
- Sealed to dust and can be optionally sealed to water, oil, chemicals
- Can be hosed down and re-used if contaminated
- Black and white camera on front; video transmitter inside
- Ideal for exploration, inspection, and transportation in areas unsafe for humans

KAA

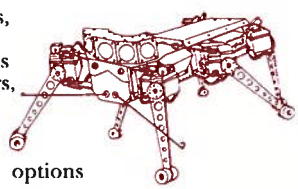
Pipe Inspection Robot



- Wraps around pipes and other vertical structures.
- 12 degrees of freedom.
- Snake-like movement on horizontal surface.
- Ideal for prototyping pipe inspection robots.

Genghis-II

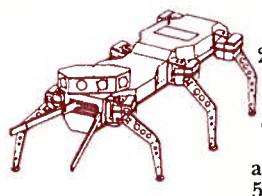
Highly Dexterous Six-Legged Walking Robot



- Basic model detects forces, collisions, and people
- Extended package includes infrared proximity sensors, surface contact sensors, and pitch and roll inclinometers
- Expansion slots for future options
- Ideal for ALife behavior learning and evolution studies

Nero

Advanced Legged Robot



- Pan head carrying a video camera and pyro sensors.
- 2 mandibles with an in/out & up/down drive motor.
- Motorola 68332 processor configured on Vesta board.
- 1 Mbyte SRAM and up to 1 Mbyte EPROM.
- 55 sensors, 16 actuators and 4 output devices available.
- Ideal for ALife experiments and prototyping advanced mobile robots for rough terrain.

IS Robotics — Exploring the Future →

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Subsumption Architecture robots are conceived by Artificial Intelligence Laboratory of the Massachusetts Institute of Technology(MIT) and are built for AAI by IS Robotics. Robots are programmed in Behavior-Based Intelligence(SA).