CENTRE FOR INTEGRATED COMPUTER SYSTEMS RESEARCH •C•I•C•S•R•

CICSR FOCUS

THE UNIVERSITY OF BRITISH COLUMBIA

Building virtual environments with reality-based modelling

Dinesh Pai's research is breaking new ground in real-time sound & object deformation simulation

Dinesh Pai and ACME: "In the near future, you will not only see a 3D object, but also be able to pick it up and feel it."

If virtual reality is to be more real than virtual, then objects must not only look realistic, but sound and feel realistic as well. Dinesh Pai has taken on this challenge-the CICSR member's work in reality-based modelling is helping to flesh out virtual environments, and to improve the feel of human-machine interfaces that require the real-time simulation of remote or virtual interactions.

"I want to build rich computational models of the physical world," says Pai, an associate professor of Computer Science who specializes in computational robotics. "Models that are based on actual measurements-this is the reality part-and that can support interactive simulation."

Extending virtual reality

"The idea," explains Pai, "is that, in the near future, in any sort of virtual environment, you will not only see a 3d object, but also be able to pick it up and feel it. And when you put the object down it will make a realistic sound. You'll be able to interact with these environments."

The realistic models and interfaces Pai and his team are creating will have an impact on everything from computer games to training simulations to microsurgery. The technology could also be used, for example, in the remote assembly of industrial components over the Internet.

Reality-based modelling starts with the measurement of real objects, and the capture of contact feedback and audio characteristics. Pai is leading a team of faculty, staff, and students that is developing ACME, the Active Measuring facility. The team includes students Doug James, Jochen Lang, Derek Difilippo, Paul Kry and Josh Richmond.

ACME is an integrated system that includes a robot arm to capture contact data, a 5 degree-of-freedom field measurement system that measures the sound and

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CICSR Director's Corner

The academic year begins again, which means it is time for CICSR's 11th annual Distinguished Lecture Series. We have another great line-up of speakers, so be sure to read the poster that accompanies this issue of *FOCUS*. (The speakers and dates are also found on page 8.)

In this issue we profile the innovative work of four CICSR members. The common thread is their collaborative approach to research-many of them work in teams to solve their research problems.

Dinesh Pai is leading a team into virtual territory; Peter Lawrence's group is improving sawmill performance; Yair Wand and Carson Woo are investigating the relationship between organizations and their information systems; and Andre Ivanov is developing self-testing microchips.

We also pay a tribute to Bob Evans, who steps down as head of UBC's Mechanical Engineering department. I have enjoyed working with Bob in my role as CICSR director, and thank him for his contributions over the years.

Lastly, don't forget to note that the National Science Foundation's Year 2000 conference will be held here in Vancouver, January 3-6. CICSR member Yusuf Altintas is co-chair of the proceedings.

Rabab Ward, CICSR Director

Virtual environment, continued from page 1

light field around an object, and a laser range measurement system. The ACME system also permits remote modelling, so that researchers can interact with ACME over the Internet.

Real-time simulation

With measurements obtained through ACME, Pai can then build accurate models of objects and their characteristics. He is particularly interested in the real-time simulation of the sounds and forces produced by contact, since these provide important perceptual cues for users interacting with simulated objects.

Dinesh Pai

Over the past 4 years, Pai and his team have developed a framework for the simulation of sounds caused by the contact or collision of physical objects in a virtual reality environment.

"The framework is based on the vibration dynamics of bodies," says Pai. "The computed sounds depend on the body's material, its shape and the contact location."

These simulated sounds give a user important auditory cues that lend a larger sense of reality to the objects in the virtual environment. Another important sense-cue is object deformation.

In recent years, huge advances in simulating 3d objects have been made. But much of that work has focussed on the shape and texture of objects. And shape, as Pai points out, is only the beginning.

"You want to know what an object feels like," he says. "If it's a soft object and you push on it, how does it behave?"

One potential application of deformation simulation is surgical training. Medical students could practise surgical procedures on computer-modelled tissues that deform as students cut them with virtual scalpels.

Real-time simulation of object deformation, however, is far more difficult than sound simulation because the act of deforming an elastic object is computationally expensive. But one of Pai's doctoral students, Doug James, has developed a highly efficient method for deformable object simulation that was presented at SIGGRAPH this past August.

Industry support

Pai, who is a past ASI fellow, has enjoyed steady industry support. Partners include Point Grey Research and International Submarine in BC; Haptic Technology Inc.; MPB Technologies in Montreal; and Virtual Technologies in Palo Alto, Ca.

"They've been supporting us with their equipment," says Pai, noting that Virtual Technologies has loaned his group CyberGloves, and Point Grey Research has contributed trinocular stereo systems.

International Submarine was interested in Pai's research because it builds robotic arms for submarines and the Canadian space agency. Now CICSR is trying to combine that company's interest in telerobotics with Pai's research in reality-based modelling. And Virtual Technologies wants to see how deformable object simulation can be plugged in with its CyberGlove.

"In a sense," says Pai, "we are pioneering these technologies."

For more information, contact Dinesh Pai at pai@cs.ubc.ca or (604) 822-8197.

Self-test part of microchip revolution

Andre Ivanov develops built-in self-test technology for the next generation of microelectronic devices

Exponential growth in the complexity and functionality of microchips is the norm in the microelectronics industry. Moore's Law states that the number of transistors on a microchip doubles every 18 months. Today there are 21 million transistors on a typical microprocessor chip; in 2012 the Semiconductor Industry Association predicts that number will grow to 1.4 billion.

This warp-speed growth creates enormous pressure on chip manufacturers, as market demand threatens to outstrip their ability to design and test fault-free microchips and quickly bring them to market in a cost-effective manner.

Andre Ivanov, an expert in integrated microelectronics engineering (IME) is helping to relieve that pressure by developing IME test tools and techniques that will save chip manufacturers time and money.

BIST and SOC

Ivanov, a CICSR member and associate professor of Electrical and Computer Engineering, develops special circuits and CAD tools that verify digital, analog and mixed-signal circuits. His most recent work focuses on new testing techniques such as built-in self-test (BIST) and its use in emerging system-on-a-chip (SOC) technologies.

Microchip manufacturing is an imperfect process, and random defects are a reality. Testing is a vital step in the manufacturing process as it detect faults; but the automatic testing equipment (ATE) that manufacturers use to test chips is very expensive to buy and run. And since chip designs change so quickly, manufacturers struggle to keep testing technology abreast of microchip development while amortizing their current ATE investment.

"It's a losing battle," says Ivanov. "Testers are required to verify and test state-of-the-art circuits—but how can they keep ahead of state-of-the-art when the testers are built from the same technology? It's a moving target."

"And it doesn't make sense for testing to be more expensive than design and manufacture," adds Ivanov, a past ASI fellow.

This frustration was the impetus for BIST. Over the years, researchers have mulled over the possibility of self-testing circuits that would eliminate the bottleneck and expense of ATE testing.

But chip designers, until recently, could not afford to allocate any circuitry on their chips to a BIST function. With transistors now numbering in the millions on a single chip, BIST functionality is today a practical reality.

State-of-the-art testing

"A big advantage is that BIST allows for state-of-the-art testing," explains Ivanov. "By having the technology test itself, the testing keeps pace with the latest developments in chip design."

This includes system-on-a-chip (SOC) technology, another focus of Ivanov's work. SOCs are portable miniature systems that fit on a single microchip. SOC applications run the gamut from household appliances to life-critical, in-body devices such as pacemakers or micropumps that regulate in-body medicine delivery.

"SOC is the enabling technology for tomorrow's systems," says Ivanov. "But how do you figure out what's wrong with a miniaturized microelectronic or micromechanical system? You can't reverse engineer or diagnose it. That's why self-test and monitoring are so important."

Ivanov is currently developing a BIST circuit that will monitor the power supply for portable low-power devices.

"There's a demand for low-power electronic gadgets with more and more features," explains Ivanov. "But battery capacity has not kept pace with the evolution in electronics."

The BIST chip is designed to optimize battery power and detect faults on- and off-line. Ivanov hopes the chip will make electronic devices more reliable and sees it as having particular utility in life-critical applications, such as pacemakers, where power supply monitoring is vital.

Andre Ivanov: "By having the technology test itself, the testing keeps pace with the latest developments in chip design."

New areas of development

To Ivanov, BIST and SOC promise to open new areas of microelectronics development. A chip in an automobile, for example, could test itself and communicate the resulting diagnostics to the manufacturer. Self-diagnosis could lead to self-repair, an innovation that Ivanov believes would usher in an era of ultra-reliable microelectronics-based systems.

"We're living a revolution," he says. "Everything is going to be riding on SOCs. And if you build in self-testing, you can build the product correctly and cost-effectively and get it to market on time," says Ivanov.

Ivanov has strong support from the microelectronics industry including Canadian Microelectronics Corporation, the BC Advanced Systems Institute, Micronet, and PMC Sierra.

Andre Ivanov can be reached at ivanov@ece.ubc.ca or at (604) 822-6936.

Aligning information systems with business goals

Yair Wand and Carson Woo developed a new method of object-oriented enterprise modelling and are using it to help organizations change during competitive times.

Carson Woo

Yair Wand

Most organizations now depend on computers to automate business tasks such as order processing and customer billing. Sophisticated computerization, however, can create difficulties for organizations when it comes time for them to change or "reengineer," an inevitable occurrence in today's competitive business environment.

The need to adapt existing systems can become an obstacle to successful change. As well, organizations often acquire packaged systems that do not fit well with their business model, thus imposing system implementation considerations on business decisions. To Carson Woo and Yair Wand, this is like putting the cart before the horse.

Unique method

Woo and Wand are associate members of CICSR and professors of Management Information Systems (MIS) in the Faculty of Commerce. Their specialty is the use of models to support the analysis, design and construction of information systems (IS). Dissatisfied with traditional methods of systems analysis, they have developed a unique method of object-oriented enterprise modelling (OOEM) to help businesses align their information systems with their business goals.

"What we advocate is using the business model as a guide to developing information systems," says Woo. "Our overall goal is to promote a better fit between the business and its information systems, and to reduce the time and resources needed to develop information systems."

Wand and Woo approach the problem by breaking it into three steps. First, they construct an organization's business model, i.e. a description of its mission, and products and services. Second, from the business model, they derive the "ideal" IS architecture. Third, they reverse-engineer existing or proposed information systems into the underlying business model by linking existing system components to business functions.

True needs of an organization

This process enables them to conduct a "match-gap" analysis between the true needs of the organization (as implied by the business model) and pre-existing components (whether part of the current information systems portfolio or a new, proposed package). This analysis can then be used to guide the adaptation process, to support reusability and to evaluate the appropriateness of new IS solutions.

Wand and Woo found that existing object-oriented methods lacked precise rules for modelling enterprises. Borrowing from ontology, the branch of philosophy that considers models of reality, they derived a clearer definition for the role of objects in modelling and a set of rules for constructing enterprise models.

"We have tested and improved OOEM over the last six years through instruction, graduate research, and practical large-scale application," says Wand. "We have found the approach useful in constructing unambiguous, easy-to-understand models of both an enterprise and its IS architecture."

The new approach allows for an IS evaluation in terms of business needs and processes, rather than by an exhaustive examination of system features. Shifting the focus from IS details to the bigger business picture has the potential of making companies faster on their feet when it comes to re-engineering business processes, introducing new products and services, or migrating to new information systems.

Obvious and essential

"People say later, 'it is so obvious we should have thought about it sooner,'" says Woo. "What essentially matters is the business rather than specific implementation details."

Wand and Woo have successfully applied their novel approach to companies in the telecommunications and oil industries where competition and change is intense.

Woo recently completed a sabbatical at BC Tel Mobility in Vancouver, BC, where he introduced that company to the OOEM approach. He and Wand are hoping to garner support from other companies who are beginning to show interest in their enterprise modelling method.

Yair Wand is at (604) 822-8395 and yair.wand@ubc.ca; Carson Woo is at (604) 822-8390 and carson.woo@ubc.ca

Speeding and improving lumber grading

A CICSR team led by Peter Lawrence is working with CAE Newnes Ltd. to develop the latest generation of automated lumber grading systems

The next generation of automated lumber grading machines will soon be on the job, thanks to a Precarn-supported project by a CICSR research team and its industrial partner.

CICSR member Peter Lawrence is leading the UBC component of a team that is designing a more effective automatic lumber grading system along with CAE Newnes Ltd. of Salmon Arm, BC.

Cross-disciplinary team

The CICSR team is a cross-disciplinary group that draws on the talents of 7 researchers: Professors Lawrence from Electrical and Computer Engineering, Gary Schajer, from Mechanical Engineering, Dave Barrett, of Wood Science, and Frank Lam, also of Wood Science. The team also includes Hossein Saboksayr, a CICSR graduate student, Wilson Lau, a Wood Science graduate student, and Greg Grudic, a consultant and former graduate student in Electrical and Computer Engineering.

CAE Newnes is one of the world's leading manufacturers of automated sawmilling and woodprocessing equipment. The company pioneered automated grading with an x-ray system that sorted boards faster and more accurately than the human eye.

Benefits of accurate grading

Fast, accurate board grading has two major benefits. It speeds wood processing and increases economic return by singling out strong, high-value boards. These boards are streamed into the fabrication of valuable products such as engineered beams and trusses.

Now the CICSR team is bringing lumber grading into the digital age by combining advanced digital signal processing and microwave technology to improve the x-ray system. The new system, which CAE Newnes plans to build and market, will bring automated grading up to mill speed while improving grading accuracy.

The system is designed to run unattended on a production line. As boards come out of the sawmill they are bumped into sequence past a scanner which uses sensors to measure each board for density, slope-of-grain and knot location. The measurements are then computed to make a strength estimate of each board. This estimate is matched against a database that assigns the board its grade and finally prints it on the lumber.

The research team's major challenge is combining accurate grading with high board throughput. With sawmills running at speeds of up to 2,000 board feet per minute the system has to scan, analyze and match board data at a remarkable rate.

Team expertise

The team draws on the wide-ranging expertise of its members to solve the problem. Lam and Barrett contributed their knowledge of wood strength and mechanics, while Schajer's expertise in microwave technology and Lawrence's digital signal processing experience tackled the data analysis side of the problem.

"It's a project that is exceptionally multidisciplinary," says Lawrence, a past ASI fellow. "We've tapped into the knowledge base of CICSR people and others to make this happen."

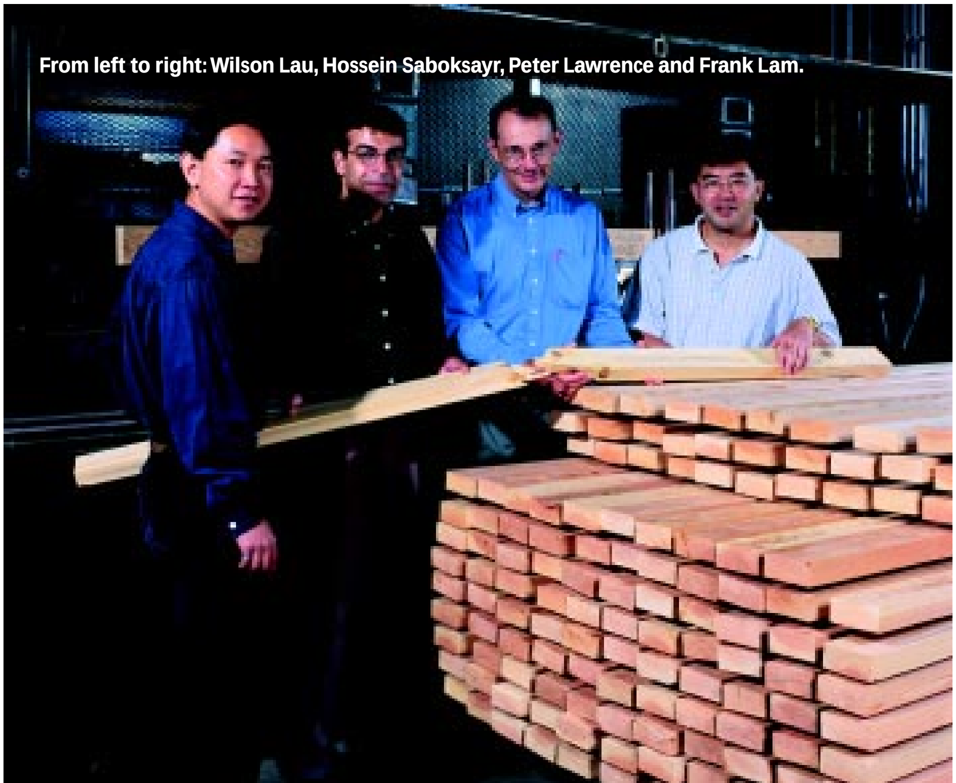
The team relies on statistical methods and functional approximation theory to build a system that will successfully and quickly capture and classify a large number of measurements. The classification scheme is being refined and simplified by Saboksayr. A neural network is being engineered so the system can train itself to learn board characteristics and build a database. Board information will be supplied on a CD-ROM as a system reference.

The system promises to significantly improve the return on graded lumber. Landmark Truss & Lumber of Abbotsford, BC will be a testbed site for the new technology.

"It's a classic case of adding value to our important timber resource," says Frank Lam.

The $1.4-million project is being funded by CAE Newnes and Precarn Associates, and will be completed by March 2000.

Peter Lawrence can be reached at peterl@ece.ubc.ca and (604) 822-5934.



From left to right: Wilson Lau, Hossein Saboksayr, Peter Lawrence and Frank Lam.

Evans ends term as head of Mechanical Engineering

When Bob Evans, of Mechanical Engineering, was asked what he looked forward to as he prepared to step down as head of the department, he answered with one word: "Time!"

"I'm looking forward to having time for reading, writing and generally catching up with my research work," he added. "And having more time to spend with my family."

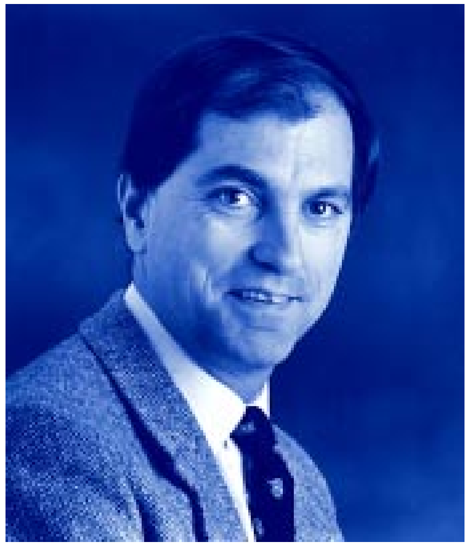
Evans has been head of the department for five years and before that was associate dean of Engineering Student Services for three.

"Over the last five years Bob Evans has provided exemplary service to the Faculty of Applied Science," says Michael Isaacson, dean of Applied Science. "He has taken the department through some very positive changes."

One of those changes was bringing new faculty members into the department.

"We have made some outstanding appointments of young faculty members who will lead our department well into the next century," says Evans.

"I believe that faculty renewal is one of the most important tasks that a department head can take on."



Bob Evans: "He has taken the department through some very positive changes."

He also oversaw equipment and course improvements in the undergraduate program. Over the past five years, the department has upgraded its undergraduate laboratories, and introduced a one-week undergraduate machine-shop practice course that has been well received by students.

Budgetary issues are a constant source of difficulty for university administrators, and Evans has had to face his share. "We have continued to see reductions in our operating budget each year, with the resulting loss of both faculty and staff positions."

Evans credits CICSR with helping to lessen some of that financial burden, and contributing to the continuing success of the Mechanical Engineering department despite its budgetary setbacks.

"CICSR has had a very positive impact on our department," he says. "Through the faculty appointments and operating funds made available by CICSR we have been able to greatly strengthen our research activities in the areas of controls, robotics and manufacturing."

As for the future, Evans sees the department consolidating its position as one of the strongest ME departments in Canada.

"We have an extensive and varied program of research and a very solid teaching reputation," he says."I think we will see more team-work as our faculty members join together to move to the next level in their research activities."

The department itself has moved to a new level, thanks to Evans's leadership. Dean Isaacson sums it up: "We are all deeply grateful to Bob for his invaluable contributions."

National Science Foundation's Year 2000 conference to be held in Vancouver

Vancouver will be the host city for the National Science Foundation's annual Design and Manufacturing Research Conference. This international conference will be held January 3-6, 2000, at the Vancouver Convention Centre. The conference features current research and provides a focused gathering for the best design and manufacturing researchers in North America. The conference is being co-chaired by CICSR's Yusuf Altintas (ME) and the University of Washington's Tony Woo. Sponsors include the US-based NSF, Canada's NSERC and NRC, and Mexico's CONACyT (Consejo Nacional de Ciencia y Tecnologia). After the conference on January 7 and 8, UBC will host two related events: a Symposium on Design Engineering and Education in Canada, and an NSF/CONTACyT/NSERC Trilateral Workshop on Environmental Design Engineering. Elizabeth Croft is the local chair for these events. Go to **http://deed.uwindsor.ca/~deed/deed00/** for more information. For more information about the NSF Year 2000 conference, see **http://www.engr.washington.edu/~uw-epp/nsf/**.

CICSR Passing Notes

New CICSR member

Sander Calisal of Mechanical Engineering (ME) joins CICSR as a new member. Calisal's research interests are ship hydrodynamics and experimental naval architecture, and the application of computer technology to ship design. Current research projects include a study of the safety of small craft and ferries, which is been performed in cooperation with a group of researchers at the ME naval architecture laboratory and the BC Research Institute towing tank. Calisal's work with Dale Cherchas was profiled in the last issue of *FOCUS*.

Altintas is new ASME Fellow

Yusuf Altintas (ME) was elected a Fellow of the American Society of Mechanical Engineers (ASME) in November 1998. The appointment recognizes his contributions to machine milling and computer numerical control (CNC) research. Altintas began a sabbatical this past July, and is now at the University of Florida where he is working with J. Tlusty, an internationally known CNC expert.

Axel Meisen appointment

The former dean of Applied Science, **Axel Meisen**, has been appointed the new president of Memorial University in St. John's, Newfoundland.

Rabab Ward made Fellow of RSC

CICSR Director **Rabab Ward** has been elected a Fellow of the Royal Society of Canada in recognition of her contributions to image and signal processing. The society citation read: "Rabab K. Ward, is a leader in the application of digital signal processing theory to cable and high-definition television, medical images, restoration of astronomical images, and extraction of an infant's distress level from his/her cry signal. Being a highly accomplished researcher and a prolific inventor, she has an impressive list of publications and patents, and her work is used in various companies and laboratories worldwide. Examples include her non-intrusive method for measuring the picture quality in cable TV systems, the non-interfering video system used by the aquaculture industry, and the fluorescence microscope system used by cell-biology researchers."

New Master of Software Systems program

This new program is designed for students with Bachelor degrees in areas such as the mathematical and physical sciences, operations research and engineering (other than computer science and computer engineering). The program's duration is 16 months and is composed of 30 credits taken in 3 semesters and a 4-month industry internship. For more information, please visit the web site:

www.cicsr.ubc.ca/mss/index.html

Master of Software Systems

Iamascope to be on exhibit at the Millenium Dome in London

The Iamascope, developed by **Sid Fels** (ECE) while carrying out research at ATR Labs in Japan, will be on exhibit at the Millenium Dome in England for 18 months starting in November. The Iamascope uses digital image and sound technology to give a modern version of the familiar kaleidoscope. Computer video, graphics, vision, and audio technology are combined to create sound and imagery in pleasing patterns. The viewer provides the image from which the patterns are developed, and can control both image and music through body movement. For more information, visit the Iamascope website: http://www.mic.atr.co.jp/organization/dept2/Iamascope/index.html.

Dale Cherchas: acting head of ME

Dale Cherchas has taken on the role of acting head of the Mechanical Engineering department, replacing Bob Evans (see story on page 6).

Into the Millenium

The 1999-2000 CICSR Distinguished Lecture Series

CICSR is hosting its 11th annual Distinguished Lecture Series, bringing in academic & industrial leaders in the forefront of their fields.

Lectures are free and start at 4:00 in room 208 of the CICSR/CS building, 2366 Main Mall, UBC.

DLS LECTURE #1

RICHARD STALLMAN
Free Software Foundation, Ma

▶ **September 23, 1999**

Freedomware: The GNU/Linux System and the Free Software Movement

DLS LECTURE #2

MARY SHAW
Carnegie Mellon University, Pa

▶ **October 28, 1999**

Building Software Systems from Parts: How Software Architecture Helps Explain Why It's Hard

DLS LECTURE #3

NORM JOUPPI
Compaq Computer Corp., Ca

▶ **November 18, 1999**

Mutually-Immersive Mobile Telepresence: E-Travel

DLS LECTURE #4

JAMES MACFARLANE
International Submarine Engineering, BC

▶ **January 27, 2000**

Marine Robotics Past, Present and Future

DLS LECTURE #5

MARC LEVOY
Stanford University, Ca

▶ **February 24, 2000**

The Digital Michelangelo Project

DLS LECTURE #6

IAN BLAKE
Hewlett-Packard Laboratories, Ca

▶ **March 23, 2000**

Cryptographic Protocols

C·I·C·S·R· Centre for Integrated Computer Systems Research www.cicsr.ubc.ca

The UBC Centre for Integrated Computer Systems Research (CICSR) is an interdepartmental research organization made up of computer-related research faculty members in the departments of Computer Science, Electrical and Computer Engineering, and Mechanical Engineering. Currently, there are more than 70 CICSR researchers who direct over 300 graduate students and collaborate with dozens of industrial firms in areas such as robotics, artificial intelligence, communications, VLSI design, multimedia, and industrial automation.

Return Address:

CICSR, University of British Columbia
289-2366 Main Mall, Vancouver, BC, V6T 1Z4
CANADA

Editors: William Knight, Linda Sewell
Design: wilyum creative
Photos: Janis Franklin, Biomedical Communications
Office: University of British Columbia
289-2366 Main Mall
Vancouver, BC, Canada, V6T 1Z4
Tel: (604) 822-6894 **Fax:** (604) 822-9013
E-mail: cicsrinfo@cicsr.ubc.ca
Contact: Linda Sewell, Publications Coordinator, CICSR Office