

School of Information Technology

Research Report 2000

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School Research Committee

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SWINBURNE UNIVERSITY
OF TECHNOLOGY

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Introduction

The School of Information Technology is located on the Hawthorn Campus which is only 7km from the Melbourne city centre with convenient transportation and a lovely location.

In 2000, Swinburne University of Technology is progressing towards research-intensive as one of the missions. The School has established two new research centres in Information Technology. At this stage, the school has the following major research centres and groups (alphabetical order):

- Australian Institute of Computer Ethics (AICE)
- Centre for Internet Computing and E-Commerce (CICEC) – newly established
- Centre for Molecular Simulation (CMS)
- Centre for Software Engineering (CSE) – newly established
- Information Technology Innovation Group (ITIG)
- Swinburne Computer-Human Interaction Laboratory (SCHIL)

The school is aiming at well-focused research areas to maximise outcomes with the available resources in order to have more high quality publications, to be awarded more research income, and to attract more research students.

This report contains research activities in 2000 within the school. It addresses the missions of research centres and research projects. It also included international visitors to the school and external activities conducted by staff of the school. There are many other live issues available at our research Web site.

Mission Statements and Staff

Australian Institute of Computer Ethics (AICE)

AiCE pursues such aims in Australia as to provide research leadership, to inform and educate the public, and to provide a consultancy and advisory service in the field of Computer Ethics. AiCE will help to develop material to teach future IT professionals and retrain current ones, consult with industry, provide policy input, conduct research, workshops, seminars and conferences. AiCE aims to raise awareness, promote debate, and offer solutions.

Daniel Blackman
Oliver Burmeister
Chris Simpson (Chair)
Sharmini Thurairasa

Centre for Internet Computing and E-Commerce (CICEC)

CICEC performs innovative research into the development and application of Internet technology for Internet computing and electronic commerce. Our primary focus is to produce insights, frameworks, models and prototypes for software developers, information technologists, software, knowledge and information systems managers and Internet entrepreneurs. Our key strength is the ability to integrate our multi-disciplinary skills and expertise with a view towards solutions to contemporary business and technological challenges.

Rachelle Bosua
Viv Farrell
Phil Joyce
Dr Gitesh Raikundalia
Dr Rens Scheepers
Assoc Prof Yun Yang (Director)

Centre for Molecular Simulation (CMS)

CMS is aiming at contributing significantly to the advancement of the fundamental knowledge of intermolecular interactions and nanosystems.

Dr Ming Liu
Prof Richard Sadus (Director)
Dr Billy Todd (Deputy Director)
Dr Guangwen Wu

Centre for Software Engineering (CSE)

The mission of the Centre for Software Engineering is to promote pure and applied research in software engineering and to become a leading research centre.

Dr Rob Allen
Andrew Cain
Prof T. Y. Chen (Director)
Assoc Prof Doug Grant
Barbara Hurst
Dr Lorraine Johnston
Dr Edmonds M. F. Lau
Dr Jean-Guy Schneider
Dr Jim Sykes

Information Technology Innovation Group (ITIG)

ITIG is an emerging group of national significance that focuses on providing high quality research and development services to the information technology industry. ITIG provides innovative and state-of-the-art computing solutions to industry problems specializing in the areas of mobile and pen-based computing, web-based technologies, and distortion-based visualization techniques. ITIG capitalises on its relationships with industry by complementing all development activities with parallel research-based programs.

Andrew Cain
Patrick FitzGerald
Dr Ying Leung (Leader)
Kon Mouzakis
John Newbiggin
Chris Pilgrim
Matthew Smith

Swinburne Computer-Human Interaction Laboratory (SCHIL)

SCHIL focuses on human-computer interaction (HCI) and cognitive engineering. In SCHIL's state-of-the-art usability laboratory we study better ways of making user-centred systems and devices. We study patterns for usability, user-centred process models for software engineering, and usability evaluation techniques and tools. Cognitive engineering extends HCI to complex real-time mission-critical systems. We study technology-mediated team coordination in high-risk operational environments, cognitive engineering in critical care medicine, and human-system integration in process control, C2, and emergency response centres.

Oliver Burmeister
John Craick (SCHIL Research Manager)
Jennifer Crawford
Dr Peter Higgins
Dr Lorraine Johnston
Dr Jim McLennan
Prof Penelope Sanderson (Director)

Research Projects

Centre for Internet Computing and E-Commerce (CICEC)

Technology of supporting business processes for Internet-based electronic commerce with wide area workflow

Y. Yang, R. Scheepers, J. Yong et al.

Business processes for Internet-based electronic commerce are of strategic importance in all organisations for economic benefits in this digital era in Australia and in the world. This project is aimed at investigating the fundamental issues involved in exploring the new generation of wide area workflow to support business processes for electronic commerce. The outcomes of this project will include a better framework for wide area workflow and novel mechanisms of tool interface and user interface for supporting computer-mediated business processes.

Workspace awareness support for real-time cooperative editors on the Internet: A framework and experimental evaluation

Y. Yang, G. Raikundalia et al.

Internet-based collaborative software technology is of strategic importance and great benefit to Australia, with its population geographically dispersed over highly distant areas. This project investigates fundamental conceptual and practical issues in supporting users' mutual awareness in Internet-based real-time collaborative editors. The collaboration needs of users are identified, appropriate supporting features identified, and enhanced collaborative editors evaluated in an experimental study with trial users.

Implementation of Web-based technologies in and between organisations

R. Scheepers, et al.

Many organisations are currently seeking to harness the fruits of the Internet revolution, not only for e-commerce, but also for enhancing cross boundary information sharing and collaboration, support knowledge management, etc. This research examines the opportunities, and managerial challenges associated with implementing Internet-based technologies, and in particular Web-based technologies, within and between organisations. The primary focus is on the implementation of organisational Intranets and Extranets. The outcomes of the research project are managerial frameworks, principles and implementation guidelines which seek to highlight and address the organisational risks and reduce the incidence of failure in such endeavours. Some of the research is done in collaboration with external partners in Denmark and the UK.

Agent-based multi-party, multi-issue negotiation for business-to-business e-commerce

I. Rahwan, Y. Yang et al.

Negotiation is a process in which two or more parties reach a mutually acceptable agreement on one or more issues. Business-to-business e-commerce offers an environment in which multiple self-interested parties need to reach an agreement. Automating such negotiations will significantly reduce the time and transactions cost and improve the efficiency of deals. This project investigates agent-based multi-party, multi-issue negotiation strategies for business-to-business e-commerce applications.

The outcome of this research will be a framework for negotiation strategies and a study of how these strategies converge if applied to large-scale e-commerce marketplaces. This research is being carried out in collaboration with CSIRO Mathematical and Information Sciences and the Department of Information Systems at Melbourne University.

Centre for Molecular Simulation (CMS)

Nanotechnology initiative

M. Liu, B. Todd, R. Sadus

We are interested in using molecular simulation and other computational techniques to gain theoretical insights into how nanosystems work. For example we are currently working on the simulation of a particular type of biomolecular rotary motor, ATP-ase. This biological molecule acts both as a proton pump (pumping H⁺ ions between different parts of a cell, thus moderating intracellular PH levels), as well as having the remarkable ability to move in a direction perpendicular to the axis of rotation (akin to the motion of a helicopter). The mechanisms of this behaviour are currently being examined with the aim of developing a model to account for the translational motion of the motor. This could potentially be a very useful application in molecular medicine.

The study of intermolecular interactions

G. Marcelli, G. Wu, R. Sadus

The Gibbs Ensemble Monte Carlo algorithm has been implemented for the prediction of phase equilibria in multiphase and multicomponent fluids. Historically, the prediction of both vapour-liquid and liquid-liquid equilibria has relied almost exclusively on approximate theoretical models or on empirical equations of state rather than on rigorous models for intermolecular interaction at high fluid densities. The advent of new computer simulation techniques provides an opportunity to apply directly our knowledge of intermolecular potentials to the prediction of fluid phase equilibria. This work has several strands:

- Investigation of three-body interactions in pure fluids. This work has found that three-body repulsion has an important role in determining phase vapour-liquid transitions.
- The role of three-body interactions on vapour-liquid and liquid-liquid equilibria in binary mixtures.
- Simulation of membrane equilibria.
- Simulation of flexible hard-sphere chains and ionic systems.
- High-pressure liquid-liquid phase equilibria.

Phase equilibria and statistical thermodynamics

J. Wang, R. Sadus

The results of molecular simulation studies are also being used to improve the traditional basis of thermodynamic prediction. Work is currently in progress in the following areas:

- High-pressure phase equilibria of binary and ternary mixtures.
- Intermolecular interactions in aqueous systems.
- Combining rules and mixture prescriptions.
- Equations of state for ionic systems and polymer fluids.

Nonequilibrium molecular dynamics and transport properties of fluids

G. Marcelli, T. Hunt, J. Ge, B. Todd, R. Sadus

While thermodynamics traditionally deals with systems that are at equilibrium, most natural systems are actually far from equilibrium and are either evolving with time, or exist in a time-independent steady state. One can study such systems at the microscopic level by applying the principles of nonequilibrium statistical mechanics to molecular dynamics simulations. Some of the work we are currently interested in includes:

- Development of new algorithms for simulating simple and complex fluids far from equilibrium.
- Molecular rheology of polymer melts.
- Transport properties of bulk and microscopically confined fluids.
- Relationship between microscopic dynamics and irreversible thermodynamics.

Centre for Software Engineering (CSE)

Fault-based Software Testing Strategies for Logical Expressions

T. Y. Chen, E. Lau, et al.

Logical expressions are frequently found in predicates inside programs, as well as in software specifications, to describe the complex conditions for a segment of program codes to be executed or for a particular function of a program to be performed. Existing software testing strategies for logical expressions either lack solid theoretical foundations, or require a large test set, or are limited in the types of faults that they guarantee to detect. This project aims at improving the cost-effectiveness of existing software testing strategies, and extending the theoretical foundations of the previous work by us and others.

Object-Oriented Software Testing at the Class and Cluster Levels

T. Y. Chen et al.

In this project, we propose a methodology for object-oriented software testing at the class and cluster levels. At the class level, we focus on testing of behavioural equivalence and non-equivalence. At the cluster level, we investigate the interactions among composite message-passing sequences.

A Fuzzy Approach to Software Testing

T. Y. Chen et al.

In this project, we apply the technique of fuzzy set to investigate the classifications of failure patterns. We also investigate the relationships between failure patterns and the effectiveness of various testing strategies.

Deriving Test Cases from Program Specifications

T. Y. Chen et al.

In this project, we investigate how to derive test cases from specifications. We are particularly interested in the test case generation techniques that are applicable to informal specifications.

Data Flow Analysis for Java Programs

A. Cain, T. Y. Chen, D. Grant

In this project, we investigate how to use the technique of data flow analysis to identify questionable coding in Java programs. The technique of program instrumentation is used to implement a dynamic data flow analysis system for Java programs.

Swinburne Computer-Human Interaction Laboratory (SCHIL)

Cognitive engineering approaches to C2 environment

P. Sanderson, M. Watson

The C2 environment is complex, distributed, time-pressured, and risky. Information technology supporting commanders must afford timely, effective response by commander, must provide timely, accurate feedback, and must be reconfigurable in the face of contingencies. Moreover, commanders need to be able to construct awareness, make decisions, engineer situations, and evaluate effectiveness in real time, often in the face of unexpected events. We combine a cognitive systems engineering (CSE) approach to the problem of modelling C2 environments and commander decision making with a critical-incident based approach founded on participant reports of C2 in recent engagements such as the Gulf War, Bosnia, Somalia, the Falklands War, etc.

Cognitive engineering approaches to alarm management

P. Sanderson, M. Watson

At present, alarms in operating rooms and intensive care environments are poorly differentiated by users. Alarms are often ignored because they seldom convey information that must be acted upon. HCI researchers are starting to work with health care specialists to provide integrated IT solutions that will provide more timely, accurate and interpretable information about alarms to be used in high risk, time-restricted environments. In the present research we apply cognitive engineering principles to this problem, with a view to developing a theoretical and practical basis for the design of alarm systems in the future. Our present orientation is to contrast two approaches to alarm design and monitoring in critical care environments: an AI-based "smart alarm" approach vs a cognitive systems engineering approach that focuses on the display of information that focuses less on sharp discontinuities between normal and abnormal states and more on the design of visual and auditory information delivery systems that will support reasoning and awareness in both normal and abnormal contexts.

Information integration in support of intensive care nursing practice

P. Sanderson, A. Miller

One of the major challenges in the acquisition of complex systems is determining which of several design proposals will best fulfil the military purposes for which the proposed system is intended. However, current tender evaluation practices, which focus on the technical and performance requirements of various physical subsystems of the platform, do not explicitly take into account the work domain or the context in which the system will be used; factors which can affect system performance and safety. Although, in some cases, the results at the level of physical subsystems are evaluated against specific mission tasks, the tasks are typically those that can be anticipated by workers and systems analysts. Hence, little can be ascertained about the performance of the system under novel or unpredictable conditions. By identifying the functional constraints of a work domain, which are independent of particular circumstances, work domain analysis provides a framework for tender evaluation that is able to accommodate a large number of system responses to both routine and unpredictable situations. This approach was used to support the acquisition of an Airborne Early Warning and Control (AEW&C) system for the Australian Defence Forces. Specifically, the purpose-related constraints of the AEW&C system were used to derive a set of mission functions against which the performance and technical solutions of alternative design proposals were evaluated. Such a framework moved tender evaluation beyond a focus on physical subsystems to whether the design solutions would fulfil the functions of the AEW&C work domain, under both routine and unpredictable conditions.

Information Technology Innovation Group (ITIG)

CrashStats – VicRoads Road Accident Database

C. Pilgrim, K. Mouzakis, J. Newbigin, P. FitzGerald

ITIG has worked in conjunction with VicRoads to develop the CrashStats which is a web-based system providing access to a database containing Victorian Road Crash Statistics. The CrashStats system is accessible to the public from the VicRoads web site and allows queries to be created with minimal effort through the use of a simple and intuitive interface. Accident sites and road lengths can be spatially selected using interactive mapping tools and query results can be presented as summaries, accident listings, site ranking reports or they may be plotted on maps.

Ericsson Radio Systems Project

Y. Leung, C. Pilgrim, K. Mouzakis

The design brief for this project was to develop and test call handling interfaces for a touch screen mobile phone with a screen size of 28 x 85 mm. The client was interested in exploring different ways of representing call states, particularly in relation to the construction and manipulation of conference calls. They were also keen to investigate the utility of direct manipulation as a method of managing call handling functionality. Two prototypes were developed which implemented different spatial metaphors to represent call space. A user-based evaluation of the prototypes was conducted which was benchmarked against a simulation of a commercially available interface equivalent.

DSTO/Australian Army “Chain of Command” Project

Y. Leung, C. Pilgrim, K. Mouzakis, J. Newbigin, M. Smith, P. FitzGerald

ITIG has had a long-standing collaboration with DSTO to provide portable computing solutions for Project Wundarra (Soldier of the 21st Century). The most recent project in the series involved working with the Australian Army to develop a mobile pen-based system to facilitate the accelerate the creation of orders, and the passing of those orders down the military hierarchy electronically. The software development involved the creation of an application that would allow orders to be created according to defined headings, including textual orders and maps with vector-based overlays. Data was then transmitted through a military radio connection between handheld computers and base-station PCs. The software also includes a real-time collaborative map drawing and annotation system used when creating and discussing orders.

DSTO “Personal Data Recorder” Project

Y. Leung, C. Pilgrim, K. Mouzakis, J. Newbigin, P. FitzGerald

After seeing the potential in hand-held computing from previous ITIG projects, DSTO commissioned ITIG with the goal of developing a generic data collection tool for the use of observers of military exercises. The Personal Data Recorder (PDR) system not only recorded all required events but traced GPS locations and time for all user interactions, allowing DSTO to cross-reference data collection with geographical locations over time. The PDR also allows the recording of audio and electronic ink annotations, which may be cross-referenced with assessment items. To facilitate timely analysis of data, all data was transmitted in real-time over radio modems back to a base-station PC.

International Visitors

Daniela Busse, University of Glasgow, United Kingdom

Prof. Patricio Cordero, University of Chile, Santiago, Chile

Prof. Peter Cummings, University of Tennessee, Knoxville, USA

Prof. Colin Drury, SUNY Buffalo USA

Prof. Daniel Gopher, Technion - Israel Institute of Technology, Israel

Prof. Donald Gotterbarn, East Tennessee State University, USA

Prof. Dr. Volker Gruhn, Dortmund Univ., Germany

Prof. Kiyoshi Kato, Nihon Fukishi University, Japan

Christian Kvalheim, University of Trondheim, Norway

Dr. P. L. Poon, Hong Kong Polytechnic University, Hong Kong, China

Prof. Nick Quirke, Imperial College, London, United Kingdom

Mikael Skov, Aalborg University, Denmark

Patrick Vogt, University of Basel, Basel, Switzerland

Dr. Robert Glass, Journal of Systems and Software, USA

Prof. Iris Vessey, Indiana University, USA

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External Research Activities

T. Y. Chen. Assessor for the Australian Research Council and the Hong Kong Research Grants Council.

T. Y. Chen. Program Co-Chair of the First Asia-Pacific Conference on Quality Software.

T. Y. Chen et al. 2000 Best Article Award for "Improving the Cost-Effectiveness of a Test Suite for User Acceptance Tests" in Information Systems Control Journal, Vol. 6, 32-39, 2000

G. Raikundalia. PC member of Fifth Australasian Document Computing Symposium, Sunshine Coast, 2000

Richard Sadus. Assessor for the National Science Foundation (USA), the Israel Science Foundation and the Australian Research Council

Richard Sadus. Reviewer for the American Institute of Chemical Engineers Journal, Chemical and Engineering Data, Computer Methods in Applied Mechanics and Engineering, Environmental Science and Technology, Fluid Phase Equilibria, Industrial and Engineering Chemistry Research, International Journal of Modelling and Simulation, Macromolecules, Molecular Physics, Physical Chemistry Chemical Physics (PCCP), and the Journal of Chemical Physics.

J-G Schneider. Reviewer for ECOOP 2000, ICSE 2000, OOPSLA 2000

J-G Schneider. Award from the Faculty of natural Sciences of the University of Berne, Switzerland, for the best thesis in Mathematics/Computer Science ("Fachpreis Mathematik") in the academic year 1999/2000

Billy Todd. Assessor for the Australian Research Council

Billy Todd. Reviewer for the Journal of Chemical Physics and Computer Physics Communications.

Y. Yang. Tutorial "Workflow, Agents and E-Commerce on the Web" on 3rd Asia Pacific Web Conference, Xi'an, China, Oct. 2000

Y. Yang. Chair of the Web-based Education and Learning Workshop of the 1st Int'l Conf. on Web Information Systems Engineering, Hong Kong, June 2000

Y. Yang. PC member of 3rd Asia Pacific Web Conference, Xi'an, China, Oct. 2000