

Computing – a world controlled by computer software

Professor Jonathan Bowen, *Centre for Applied Formal Methods*

You may be willing to use software for word processing and email, but would you be happy flying in an aeroplane or living within the fallout range of a nuclear power station controlled by software? Increasingly our lives are in the hands of software and their developers, often without us realising it. Sometimes development techniques can be lacking. Much software is written without sufficiently rigorous design beforehand, partly because mistakes are seen as being easily correctable. An engineer building a bridge normally does some mathematical calculations before attempting construction to check it will not collapse when used. Typically this is not the case when much software is produced. A new research centre at South Bank aims to investigate techniques to help in avoiding such pitfalls.

The Centre for Applied Formal Methods (CAFM) was set up based in the Technopark building in March. It is already one of the strongest centres within the School of Computing, Information Systems and Mathematics, with four permanent staff, including two professors, a reader and a senior lecturer, and currently six postgraduate researchers.

The Centre's goal is to carry out research work with a balance of (formal methods) theory and (applied) practice in the general area of computer science. Formal methods allow the development of computer-based systems with the benefit of a rigorous mathematical basis. They are aimed at helping to avoid the introduction of errors into the system. This process can start at the requirements stage that can be formalised, perhaps with a domain-specific notation. Indeed, this is the stage at which many errors are introduced into the system in practice, only to be discovered and removed (with luck) at the testing stage, or worse, after the system has been delivered to the customer.

The process of producing a formal specification can be beneficial in increasing the understanding of a system early in its development lifecycle. The formalisation of the system can proceed to the design stage if required, although this may only be cost-effective for high integrity systems (where safety or security is paramount, for example). The intent is to move in a rigorous manner from a normally non-executable specification to an executable program that can be compiled automatically on a computer. This may be implemented in software or hardware, or a combination of the two (known as "co-design"). The process requires engineering insight and know-how, ideally combined with suitable tools for industrial-scale systems and a formal underpinning.

Professor Jonathan Bowen, who heads the Centre, has interests in the Z notation for formal specification, hardware compilation (from high-level programs directly into a matching circuit), logic programming

for rapid prototyping, safety-critical systems and technology transfer. Professor Nimal Nissanke works in the area of real-time, distributed and safety-critical systems. Dr Ali Abdallah investigates the formal development of parallel systems using a functional programming approach and Communicating Sequential Processes (CSP, a formal notation for describing concurrent systems). Dr Toomas Plaks is interested in algorithms for application-specific high-performance processors using regular (repeated) arrays of components.

A Memorandum of Understanding has been signed with the United Nations University International Institute for Software Technology (UNU/IIST), based in Macau, with the aim of fostering research collaboration and personnel exchanges. Co-operation with existing centres in the School, especially the Centre for Concurrent Systems and Very Large Scale Integration (CCSV) is envisaged, with joint seminar series for example. Plans for a new Masters course on advanced software engineering are underway, largely based on research work undertaken by members of the Centre.

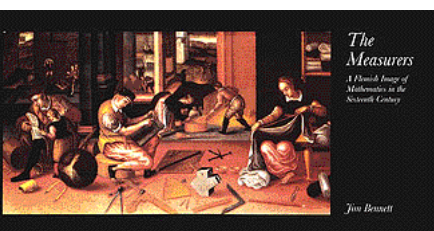
The Centre is aiming to make special use of the World Wide Web. Jonathan Bowen maintains leading international on-line resources on formal methods and related areas within the WWW Virtual Library. For further information on the Centre: www.cafm.sbu.ac.uk

Museophile.com

The University has plans to establish a spin-off company (Museophile.com) to aid museums in achieving an effective on-line presence, including features such as e-commerce, database access and educational resources. Professor Jonathan Bowen of SCISM is leading the effort. He established the Virtual Library museums pages in 1994 [www.vlmp.org], a leading portal directory of on-line museums worldwide that is supported by the International Council of Museums (ICOM) and a team of 18 collaborators around the world. He was the Honorary Chair at the inaugural Museums and the Web conference (Los Angeles, 1997) and has participated annually since then, giving a good knowledge of the on-line museum community.

Ian Sillett, the Research Contracts Manager from the Research and Business Development Office, is aiding in the process. Michael Houghton, who has extensive technical experience of commercial website design and implementation, has been appointed as a Visiting Fellow to produce a pilot website for demonstration purposes. Three museums, the River and Rowing Museum (Henley), the Museum of English Rural Life (Reading) and the Museum of the History of Science (Oxford) have agreed to participate in an example on-line museum shop that will be searchable across all the museums involved.

Contact has also been made with the 24 Hour Museum, the leading UK museum portal website [www.24hourmuseum.org.uk], and it is hoped



The Measurers: a Flemish Image of Mathematics in the Sixteenth Century Exhibition booklet from the Museum of the History of Science, Oxford ©



Einstein Blackboard Mouse Mat. Shop item at the Museum of the History of Science, Oxford ©

collaboration will be possible. Funding is being sought to progress the project beyond the pilot website. Similar initiatives are already underway in the US and Museophile.com aims to become established in Europe before foreign competition can take over.

For further information: www.museophile.com

The development of electronic commerce

Geoffrey Elliott, *Co-ordinator of the Centre for Research in BIT and E-commerce*

The School of Computing, Information Systems and Mathematics continued its growth and adventure into the Internet computing arena with the successful development and validation of an exciting new programme in Electronic Commerce (E-commerce). This innovative academic area is concerned with business computing for the 'Internet age'. The programme of study is primarily focused on the conduct of business activity through the Internet and World Wide Web. E-commerce students learn various techniques of software development using web-based languages such as Java, HTML and XML. They learn how to analyse, design, implement and evaluate E-commerce information systems. They also learn how to build Internet-based trading environments using the interface of the web. These subjects are then all brought together to demonstrate how networked computing and information technology can be used to enhance electronic trading, and other business activity, through virtual and real business partnerships.

The E-commerce programme was established to compliment and enhance the existing course provision within Business Information Technology (BIT). These two programmes form a strong base within the overarching academic and research domain of Enterprise Computing. The first student intake onto E-commerce commenced in September. By the time the first cohort graduate, it is expected that the academic discipline will encompass around 300 students, which is a reflection of the growing importance of E-commerce in today's world.

In addition to the academic development of E-commerce, the development of the programme has also paved the way for the School to take advantage of the range of both industry and academic research contacts within the Electronic Commerce domain. The Centre for Research in Business Information Technology has also been re-named to include reference to E-commerce, and to provide a broad academic umbrella for those wishing to engage in joint research within the E-commerce area. The Centre will provide a focal point to exploit the wide range of collaborative opportunities in E-commerce both internally, within the University, and externally within the wider business environment.

Digital logic design and data communication

Professor Mark Josephs, *Centre for Concurrent Systems and Very Large Scale Integration (CCSV)*

Work of the Centre, headed by Professor Mark Josephs, provides a focus for research into digital logic design and data communication. The seventh year of operation of the CCSV saw the successful completion of two research contracts.

One contract, part of the European Commission's Fourth Framework Programme, funded the Working Group on Asynchronous Circuit Design (ACiD-WG). With the award of a Fifth Framework Programme contract with a budget of 565,000 ecu, ACiD-WG is set to continue for another four years.

The CCSV acts as coordinator of ACiD-WG and there are now eighteen other members, including research teams from Denmark, Finland, France, Germany, Israel, Italy, the Netherlands, Spain, Switzerland and the UK. The top three European microelectronics companies are represented on the management board of ACiD-WG.

The other contract, this time from the UK Engineering and Physical Sciences Research Council, funded the development by Research Fellow, Dr Dennis Furey, of a software tool that translates a program-like textual description into a graphical representation (Petri nets). The former is convenient for specifying the functionality of asynchronous digital systems; the latter provides a link to automated implementation because Petri nets are suitable for input to logic synthesis tools.

In 2000, the CCSV hosted the Eighth UK Asynchronous Forum, attracting over thirty PhD students, postdoctoral researchers and academic staff from across the country. We also continued to organise internal research seminars. We said farewell to Research Scholar, Francesco Pessolano. After three years of postgraduate research training, Francesco submitted a PhD thesis on *Heterogeneous Clustered Processors: Organization and Design* and joined the Digital Design & Test department at Philips Research Laboratories, the Netherlands, as a Research Scientist. Another Research Scholar, Jun Xu, in the second year of his training, completed a report on *Asynchronous Logic versus Synchronous Logic in Packet-Switch Design*. We welcomed a second Research Fellow, Dr Igars Lemberskis, on a two-year secondment from the Transport and Communication Institute, Riga, Latvia. Dr Lemberskis will be investigating the synthesis of self-timed Finite-State Machines. Finally, a research collaboration between Senior Lecturer, Dr Sylvia Jennings, and Head of School, Professor Abdullah Hashim, promises to advance the state-of-the-art in error-control coding and in text compression.

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