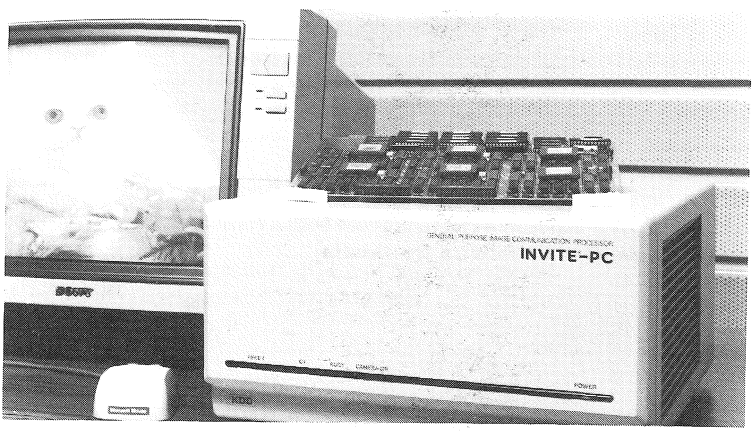
occam® user group · newsletter

No 8 January 1988

CONTENTS



Embedded transputers: Video phone developed by
Kashiwagi Labs and Kokusai Denshin Denwa, Japan

NEWS

From the Editors

Welcome to OUG Newsletter No. 8. Observant readers will notice a new section: *Letter to the Editors*; we are looking forward to being able to write the first word in the plural. Occam has even been discussed recently on the letters page of a UK national newspaper, *The Guardian*, with offerings from A.N. Richmond of Liverpool Polytechnic and P.H. Welch of the University of Kent (7 December and 17 December, 1987).

Since the presentations made at OUG Technical meetings are now being published as Proceedings, we are no longer including long accounts of such events in the OUG Newsletter, nor are we including learned papers. Nevertheless, we are pleased to receive articles in a lighter vein, together with short, newsy items.

We thank all contributors to the current issue. The deadline for material for Issue 9 is 1 June, 1988. However, reports on the various SIG meetings to take place at Sheffield would be welcome while the events are still fresh in their authors' memories.

Items for inclusion in the Newsletter should be sent on PC floppy disk (*unformatted ASCII*) to Derek Paddon (address on back page), or via email (again unformatted) to derek@uk.ac.bristol.compsci.

Derek Paddon, Mike Barton. Bristol, January 1988.

Back Numbers

Copies of Issues 1, 2, 3, 4, 5, 6 and 7 of the Occam User Group Newsletter are available while stocks last on application to the secretary at INMOS.

The bibliography started in issue 1, and the list of members in issue 2. Both have been supplemented in each issue.

INMOS do not intend to pay for any more reprints of old newsletters when present stocks are exhausted. It is hoped however to produce both a consolidated bibliography and revised complete membership list within a few months.

The OUG Questionnaire

Michael Poole, Software Support, INMOS Bristol

By now all members should have received, completed and returned the OUG questionnaire. If anyone has not yet received one please let me know and I will send another. I intend to remove from the OUG mailing list all old members who have not returned a signed questionnaire by the end of March 1988. In future I shall be including a copy of the questionnaire with the first mailing of Newsletters sent to each new member; membership will be confirmed on return of a signed questionnaire.

In this way I believe we can be seen to be fulfilling the requirements of the UK Data Protection Act, which provides safeguards to "data subjects", that is people on whom personal information is held in a computer file.

I should like to thank everyone who has returned the questionnaire and especially those who have answered the detailed questions which provide a lot of useful information. We have not yet decided exactly what to do with this beyond keeping it on file, but I hope at least to be able to give a full statistical analysis in the next Newsletter.

Having glanced at the responses when opening the returned envelopes I know that members will welcome an assurance that we do not have any immediate plans to charge a fee for membership. I will also ensure that members wishes about making the addresses available to third parties are respected. In fact very few members have asked for any restriction on the use of their names and addresses.

Perhaps the potentially most valuable information received is that on existing and potential special interest group membership. I propose to produce lists of people who have expressed particularly popular interests and send them to these people so that they can know who shares their interest.

We have had difficulty up to now in getting special interest groups off the ground. To be viable such a group needs a small number of committed enthusiasts to provide leadership and arrange appropriate activities. The OUG Committee is not collectively in a position to do anything other than provide moral support to these groups, so we hope other groups will soon follow the precedent set by the AI group of organising a joint meeting with a group outside the OUG with similar interests.

New potential SIG subjects which have been suggested by several members include the following:

Digital signal and image processing
Implementation of other languages on transputers
Simulation
Process control
Object oriented programming

Telecommunications
Computer aided design
Neural networks
Design methodologies
Databases
Scientific applications
Commercial applications
Functional languages

Many members from overseas have expressed a desire for more local activity. Again this requires enthusiasts to take the initiative. Such activities can be purely local, or if planned sufficiently far in advance can be publicised in the Newsletter.

As OUG secretary I should like to hear from people trying to start local groups, particularly so that I can pass their names to each other.

(Any members interested in joining the numerical method (scientific applications) SIG should get in touch with Derek Paddon (address on back page). This SIG has a number of Transputer users who are interested in finite element and finite difference methods, who would like to contact researchers with similar interests, Editor.)

Notice for users of the B004 and the TDS

Michael Poole, Software Support, INMOS Bristol

The current version of the occam 2 Transputer Development System for the B004 board is the IMS D700C. This is available at a small handling charge to all customers with earlier versions of the D700. Besides the curing of many bugs, the principal new features in this version are code generation for the T800 floating point transputer and a library system for declarations of occam procedures and groups of constants.

This version is the last that will include support for the T414A transputer with its byte transfer link bugs, etc. This was the transputer on B004-1, B004-2 and B004-3; its number can be read on the package.

All future INMOS software products for the B004 will only work if the T414 has been upgraded to a T414B. A special upgrade kit is available - the IMS B901, this includes a T414B transputer and a small number of other components with full fitting instructions which your technician can follow.

The next version of the TDS will be the D700D. This will include the first compiler to implement the full language as specified in the recently published Occam 2 Reference Manual (with the sole exception of in-line VALOF constructs). This language supports FUNCTIONs and the CASE selection construct, and the implementation provides a (nearly) complete implementation of all the occam compile-time checks.

The D700D will include the symbolic post-mortem debugger which was previewed by Conor O'Neill at the OUG meetings in Grenoble and Chicago. The TDS user interface will also be made substantially more user-friendly in response to feedback from the users of the earlier versions.

Without a B004-4 or an earlier B004 with the B901 upgrade you will not be able to use these new facilities, so please place your orders with your usual INMOS distributor or local office. Earlier versions of the software will continue to run on the new hardware.

Occam and transputer academic support

Colin Whitby-Strevens, Manager Special Projects, INMOS Ltd

A vital aspect of the acceptance and spread of occam and transputer knowhow is the work carried out in the universities, polytechnics, and colleges around the world. It is indeed very encouraging to see just how much is going on and the rate at which it is growing. For example, occam is now taught at undergraduate level in virtually every UK university, and, world-wide, several hundred research projects are under way. There are several excellent textbooks on the market and more are on the way.

Support available to academic institutions takes a variety of forms, both directly from INMOS and indirectly from other organisations.

* Occam user group(s). We support the OUG and see it as having a major part to play in the exchange of ideas and information. The number of local area and national groups is increasing rapidly, and we provide local support and encouragement.

* Pricing. We will discount the price of INMOS current software products, or the software components of bundled products, by a substantial amount to academic institutions. From time to time there are special academic pricing opportunities available on hardware too.

* UK Science and Engineering Research Council Transputer Infrastructure. The SERC have established five support centres (at Sheffield, Liverpool, Strathclyde, Southampton, and, pro tem, at Rutherford Laboratories). These offer expert technical support, run courses, and have major transputer installations available for use by academics and industry. In addition, the SERC run a loan pool of transputer equipment from Rutherford Laboratory, hold workshops, etc.

We hope that this initiative will play a major role in providing the focus for UK academic transputer research.

* Contacts Directory. We produce a directory of research projects, to enable researchers and project proposers to find out about each other. This is only as good as the contributions made to it - so please ensure that your project is included. The second edition is, at the time of writing, in preparation, and will list at least 250 projects. For further information, contact Claire Williams at INMOS Bristol (+44 454 616 616), or Steve Burns at INMOS Colorado Springs ((203) 630 4240).

* Electronic Mail. There is an occam grapevine and a transputer grapevine on the major USA and UK networks. Join in and contribute. Details from:
occam-request@uk.ac.oxford.prgv,
occam-request@syr-sutcase.csnet,
transputer-request@uk.ac.oxford.prg,
transputer-request@tcgould.tn.cornell.edu.

* Occam 1. Whilst INMOS no longer provides direct support for occam 1 (or proto occam), we are sympathetic with the view that it makes an excellent language for introductory courses on parallelism. We therefore have licencing arrangements to make occam 1 available to academics (normally at handling cost) from third parties. Occam 1 for VAX/UNIX is available from the University of Kent, and occam 1/TDS hosted on the IBM PC is available from the Bristol Transputer Centre, Bristol Polytechnic. In addition, several companies are planning to make occam 1 systems available commercially. In suitable circumstances we are also willing to allow access by academics to the sources of occam 1 systems, for example in order to port occam 1 onto other machines.

* Special initiatives. From time to time we run special support programmes, particularly outside the UK to complement the SERC initiative, in which we will provide both hardware and software to suitably qualified research projects. Available hardware is strictly limited and proposed projects will be closely examined. However, when the opportunity does arise, the criteria for qualification are based on (i) activity - we look for keen researchers who already have or will rapidly create their own momentum; (ii) relevance - we look for high quality projects which are timely, given the direction of technology over the next two years or so; (iii) influence - we look for industrial exploitation routes and early widespread publication of objectives and results. Make sure that your local INMOS office knows what you are doing and can offer.

* Signal processing. Having recently launched the A100 cascadable 32 point transversal filter, we are very keen to encourage the existing strengths and to support academic work in the area of digital signal processing. All interested parties please contact Nick Birch at INMOS Bristol (+44 454 616 616).

* INMOS publications. We have recently completed agreements for the main INMOS reference manuals to be published in paperback form by commercial publishing houses, and these will shortly be readily and conveniently available for use in courses etc. In addition, there are a wide range of INMOS Technical Notes, which form excellent case studies. It is planned that these too will be published externally in paperback during 1988.

* Teaching and training materials. We are willing to make available hard copies of the foils used in our introductory occam and transputer training courses. Several companies already offer or are planning products aimed at the educational market. In addition, a number of universities offer public occam and transputer courses.

If you have any needs which are not covered by the above list, then please do let us know. Where we cannot help, we will attempt to put you in touch with someone who can. In return, we would strongly encourage you to help us, youself and other transputer users by publicising you work, particularly in the international community.

Future meetings

A one day joint workshop between the BSC Parallel Processing Specialist Group and the OUG AI SIG is being held at Birkbeck College 23rd February 1988. Contact: Steven Ericsson-Zenith at INMOS. Tel 0454 616616.

The 8th Technical Meeting of the Occam User Group will be held at Sheffield City Polytechnic 27th-29th March 1988. Contact: Jon Kerridge. (see accompanying green form).

The American Occam User Group is meeting in Portland, Oregon on 11th April 1988. This meeting will be followed by a 2-day Parallel Computing Workshop run by the Oregon Center for Advance Technology Education. Contact: Martin Booth, INMOS Corp, 2620 Augustine Drive #180, Santa Clara, CA 95054. Tel: (408) 727-7771

The 9th Technical Meeting of the Occam User Group will be held at the University of Southampton 19th-21st September 1988. Contact: Prof Tony Hey, Tel 0703 559122 (Ext 2069)

For the 10th Technical meeting in Spring 1989 we are considering several options including the University of Twente at Enschede, Netherlands, and the Universities of Edinburgh and Liverpool. Anyone wishing to influence the Committee's decision is invited to talk to a Committee member.

LETTER TO THE EDITORS

Is occam due for a name change?

From Alan Chalmers, University of Witwatersrand, 1 Jan Smuts Avenue, Johannesburg.

"Entia non sunt multiplicanda praeter necessitatem" William of Occam.

The well known Occam's razor - freely translated (with apologies to Latin scholars)"Keep it as simple as possible" - and the original design philosophy behind the programming language, named after the famous Oxford philosopher himself, occam.

Does this principle still hold?

The original occam (which I shall call pure occam) only had 27 reserved identifiers (Pascal has 74, including standard types, functions etc). It was a small, but elegant language and included such innovative structures for representing concurrency and concurrent communication that it immediately stood out from other "concurrent" programming languages.

Pure occam had its drawbacks: no built in support for string, file or graphics handling: no floating-point or multiple-precision arithmetic: and like any language, users wanted addition features to make their lives easier.

Enter; occam 2 Beta release 1 (March 1986). The number of reserved identifiers had now gone up to 51. These additional reserved identifiers of occam 2 opened up new horizons to the users and occam programming had come of age.

In February 1987 the second Beta release was available. Not only have additional features been introduced (along with six extra reserved identifiers and the ability to insert any of the transputer instructions into the code (all 125 of them), but also some of the existing release 1's methods of tackling problems have been altered.

While there can be no doubt as to the power of the Beta release 2 (and I look forward; to the full occam 2 implementation), has not William of Occam been forgotten on the way? Occam 2 is by no means the "simple" language that was pure occam. Perhaps occam should be renamed Langland, after the 14th century author of the same name, who stated in his The Vision of William concerning Piers the Plowman:

"Necessitas non habet legem"

Necessity has no law;

or even, in deference to that greatest of English bards, Shakespeare, for his advice to future programming language designers in his The Merry Wives of Windsor:

"What cannot be eschewed, must be embraced"

MEETING REPORTS

Report on the 7th Occam Users Group Meeting

Andrew Dixon - University of Bristol

The 7th meeting was held last September in sunny Grenoble, France. The conference had been organised by Trian Muntean, who laid on excellent hot weather and good food. More soft drinks could have been provided to combat the heat within the lecture theatre. Accommodation was provided in local hotels, and the joys of Grenoble's night life were experienced in the evenings.

The conference, which was the first one held outside of Great Britain, was attended by many people from across the world. A significant number gave papers or short presentations, all of which will be published in the conference proceedings at a later date. The titles and authors of the various papers are given below:

Roger Shepherd	Security aspects of Occam 2
Conor O'Neill	The TDS Occam 2 debugging system
Geraint Jones	On Guards
David Pritchard	Mathematical Models of Distributed Computation
Michael Goldsmith	Occam Transformation at Oxford
A.W. Roscoe	Routing Messages through Networks
D Crookes	A Language for Transputer Networks
Nigel Dodd	Graph Matching by Stochastic Optimisation
P.J. Beynon	Multilayer Perceptron Networks
A Johannet	A Transputer Based Neurocomputer
Peter Welch	Managing Hard Real-Time Demands on Transputers
A Burns	Occam's Priority Model and Deadline Scheduling
L Mugwaneza	Operating reconfigurable Networks
P.C. Capon	Monitoring Occam Channels by program transformation
J.E. Boillat	Mapping Parallel Programs onto Transputer Networks
Mike Barton	An Occam Architecture for Reconfigurable Systems
M Mevenkamp	Transputer and Parallel Computation at the GMD
Jeff Reynolds	Transputers and Parallel Prolog
David Bosley	A Real Time Prolog Compiler
Andrew Dixon	Data Structures in Artificial Intelligence
Gordon Harp	Image Processing on the Reconfigurable Transputer
Jon Kerridge	Dynamically Reconfigurable Array of Transputers
Susan Stepney	Graphical Repr of Activity, Interconn & Loading
Yvon Kermarrec	A Transputer Network Simulator
M Meriaux	Une Application Graphique sur Transputer
I Gorton	A Distributed Arch for Simulating Micro Systems
A Bakkers	A real-time Transputer front end for control applns

Shimei Tian	Matrix Inversion
D Lafaye de Micheaux	Computational Statistics on a Multi-Trans Arch.
Jean Favre	The Solution of a system of ODE's
A Cosnuau	Experiences numeriques sur un reseau de Transputers
D.R.J. Owen	Finite Elements Calculations
J.L. Roch	Calcul Formel, Parallelisme et Occam
Klaas Wybrans	The development of a parallel C compiler
N.H. Garnett	Helios, an operating system for the Transputer
S Niar	The Occam Processes of the N-Arch Kernel

Grenoble meeting of the Hardware SIG

Tony Gore, INMOS Bristol

The objectives of the SIG, as agreed at the first meeting were reviewed.

These are:

1) To circulate details of hardware interfaces.

2) To detail tools and techniques.

3) To set hardware standards.

Not too much had happened on all of these topics, but a local meeting had taken place in Sheffield in July which seemed to have been successful, and CIX was in use as a forum for the public and private dissemination of information.

Tony Gore explained in more detail what happens when the T414 and T800 boot (information additional to that in the data sheets).

Bob Owen discussed what he would like for interfacing; he is now using the M212 to take advantage of the two parallel ports.

Alan Garrett talked about the services that QTM offer; in particular, they are the only known supplier of link cables. (INMOS only supply as part of their products).

John Nixon of Quintek discussed the need for some standards in the area of multiway link cables; Quintek have one, but this is different from the unreleased INMOS one.

After discussions, the SIG overwhelmingly decided to run as a "closed" SIG. i.e. it would keep a separate membership list, this being a subset of the OUG one. The reason for this is that it would like to circulate a newsletter. The circulation of a newsletter means that there needs to be some practical restriction, because of the costs of production and postage. The first issue of this newsletter is expected to appear about the same time as OUG Newsletter 8.

CIX would continue to be used (Tel 0483 573337) for rapid transfer of new information and as an electronic mail system. The chairman of the SIG has the CIX username of "tonygore".

If anyone wishes to join the SIG they should join the OUG in the usual way by applying to the secretary at INMOS, and should also inform Tony Gore at INMOS, or by way of CIX.

Report on Networks SIG

Simon Turner

I have received several letters over the last few months asking about aspects of networking transputers. Many of these have dwelt on ways of arranging transputers to optimise some aspect of the topology. In particular, the question "How do I build a hypercube of greater than four?" arises time and time again. Most people are aware of cube connected cycles, cubes of cubes, etc. but few are aware of the other options available, or indeed whether a hypercube is what they actually need.

A hypercube, while 'nice' in certain respects, is far from the best way of connecting processors together. If our optimisation parameter, for example, is to minimise system diameter, then the hypercube is far from effective. This may come as a surprise to some people, so a simple example may help. Consider an order-two hypercube (i.e. an ordinary 2D square) with each node having just two links available (in mathematical terms it forms a two-valent graph). This allows a network of four processors to be connected with a maximum diameter of two. Now clearly, five processors connected in a ring beats this. (The reader may like to see how many processors can be connected together in a three-valent system while maintaining a diameter of two.)

There are similar examples for higher-valent systems. For the transputer we are, of course, most interested in four- valent graphs. The reader is invited to explore various topologies while preserving a maximum diameter of say 2, 3, 4, or even higher, and submit their results to me. To whet the appetite there are published values for four-valent networks with a diameter of 2 having 15 nodes, and networks with a diameter of 3 having 35. Indeed, the reader is encouraged to try writing a program that will explore topologies and determine the maximum number of nodes for a given value of the maximum diameter.

I will present informally any contributions I receive, at the next Networks SIG meeting.

REPORT FROM UNIX SIG

P.H.Welch, Computing Laboratory, The University, Canterbury, KENT — CT2 7NF

The meeting opened with a vain attempt from the Chair to appoint a Secretary. In the light of this failure, this report of the discussions is liable to be over-coloured with the views of the Chairman on the issues raised — sorry!

The next idea from the Chair also raised little enthusiasm. This was to move our sights beyond UNIX † and take on board *environments in general* for the development of transputer applications. I am afraid I shall be pursuing this theme in this report.

The INMOS *Transputer Development System (TDS)* is designed for the single user developing his own application. With careful manually-imposed management procedures, it has been successfully applied by small teams of developers working on small to medium-sized projects. For the really large projects (e.g. 100 engineers working over 5 years with a 50% staff turnover every 2 years), some automatic support is needed. The larger companies involved in such projects already have some such support in place and are not too pleased to discover that their tools cannot be used in conjunction with the *TDS*. It is possible that this problem is the major obstacle to a wider and faster take-up of *transputer* technology — not the need to come to terms with parallel software and hardware.

As a quick solution to these difficulties, INMOS have announced the unbundling of the important tools (e.g. compilers, configurers, ...) from the *TDS*. This is being done by re-implementing in *C* — the "*occam toolset*". These tools may then be applied and controlled by "industry standard" development environments, and existing local procedures for system development may be retained. There can be no denying the attractiveness of this.

My feeling is that the principles of *occam* and *transputer* design ought to have a lot to contribute to the subject of project support environments :-

Security: environment tools may be wrapped up as (*occam* parallel) processes. This enforces the 'black box' view of software components and ensures a clean interface to other tools. No side-effects through contentious updates to common data structures are possible.

Flexibility: through the normal hierarchical building techniques of *occam* parallelism. Interfaces to key components of the environment need to be made public so that the user's own (and third party vendor) tools can be integrated. In particular, access to standard tools (like *SCCS*) and *PCTE* and *IPSE* developments need to be made possible.

Performance: an environment constructed out of a network of *occam* processes may be distributed over a multi-*transputer* host machine. Commonly used tools (like a file-server or complier) may be permanently allocated to specialised processors. Management will need to be able to re-balance the distribution of such standard services (and add and delete them) in line with demand (and experience) without necessarily having to bring down and re-load the whole environment.

UNIX does not port directly on to a *transputer*-network. For a start, we have to find a way to exploit profitably the physical concurrency available. Secondly, it seems somewhat inefficient to use a software UNIX kernel to schedule processes when we have the *transputer* micro-code. Also, *fork* is not easy to implement efficiently when there is no hardware memory management — although *vfork* is no problem.

The *transputer* itself offers little protection to a correctly functioning process (e.g. an operating system kernel) from being corrupted by a badly behaving process (e.g. a user-defined component). It is *occam* (and the enforced use of the complier with full semantic

† UNIX is a trademark of AT&T Bell Laboratories in the USA and other countries.

checking) that provides the protection. For this reason, sharing the same processor between parts of the operating system and user processes (or between processes belonging to separate user-jobs) seems to be dangerous — especially so, if one or more component is written in an alien (i.e. non-*occam*) language.

Some designers, therefore, are enforcing a strict separation of operating system and individual user applications on to distinct (electronically configured) sub-networks.

Transputer-based development environments must offer security, flexibility and performance not only for development work but also for application execution. In particular, environments which support applications through the provision of operating system kernels in every processor (e.g. for message passing/routing), and which encourage alien languages (e.g. *C*), must demonstrate that security and performance are not lost.

Representatives from MEiKO and Perihelion attended the meeting. They gave informal descriptions of the multi-user environments they are developing for multi-Transputer machines. No one was talking about a "pure" UNIX system, but they would support "most" UNIX system calls, some UNIX-like shell and the common UNIX tools. We eagerly await announcements of these systems — and the many other UNIX-like products rumoured to be coming from all around the world.

This is why I would like to broaden the interest of this SIG to include environments that are not technically UNIX. That is what is likely be around. In the longer term, I would not be surpised if the high communication/high computation bandwidths of *transputer* networks did not inspire novel approaches to support environments that were 'UNIX' only skin deep, if at all.

Grenoble meeting of the OCCAM Learning SIG

Sandy Riach, ITEC Consultancy Unit, London W10 6TH

This was the first meeting of the Learning SIG and was reasonably well attended – considering it was placed against some strong opposition in the other, more established, SIGs. A lot of the people known to be already involved in the teaching/training of occam attended and this lead to an informed as well as a lively debate.

The discussion first centred on the need to share our experiences and ideas of teaching/training people in the methodologies of programming in occam (and to a certain extent in CSP). Equally it was felt that it would be important to share the teaching materials that people have developed as much as possible – allowing for the constraints put on some participants by their publishers about giving away the contents of their books. The reasons for this desire to share are that occam and the concepts implied by programming with communicating sequencial processes are sufficiently new to mean that there is not an existing body of knowledge about what are the better strategies for teaching/training people in their use. It was felt that the OUG members are in a special position to help build up that knowledge.

Most of the people at the meeting were from higher education establishments (in USA and Africa as well as Europe) and their experiences were mainly of teaching existing programmers a new language (occam) and its associated concepts. It was felt that experience of teaching/training naive programmers (and by that I mean those new to programming) was missing from those gathered – so those of you out there with this experience could provide valuable ideas and help. Alan Burns asked about experiences of how to teach/train people from other professions such as Doctors, Physicists, etc.

In the discussions that followed some people described what they had been doing – Electrical and Electronic Engineers were as much in evidence as those with a Computer Science background. Electronic engineers it would seem take to the ideas of concurrency easier than, say computer scientists (who it was said ALWAYS have immediate deadlock problems) although the presumption was that the experience of the computer scientists would tell in the end. Although we did not discuss much of the hardware issues there were some who were developing teaching materials in this area – e.g. Roger Peel. [Maybe we can persuade him to share them when he's fininshed?]

Most of those who had been teaching/training people to program in occam felt that occam 1 was a better introductory language (e.g. the syntax was easier and only covered one page) especially for introducing concepts such as concurrency. When the learner was ready to develop more serious applications then a move to occam 2 was not felt to be an arduous task.

There was a well expressed feeling that there was a need for the development of a methodology for teaching/training people to safely program on parallel architecture machines. To this end Peter Staine-Clark and David Crowe of the Open University put forward a formal method that uses a simplified sub-set of CSP as a system definition and subsequent transformation rules for the coding of this into occam. They are developing a course at the OU using this methodology. To emphasise the importance of sharing materials they have made their course material (again occam 1) available to other members of the Learning SIG – THANKS !!

Report on Formal Techniques SIG

Bob Stallard, D.M.England Ltd, Woodley, Berks, RG5 3PQ

This group trundles along quietly away from the more immediate concerns of soldering together T800s. Dr Geraint Jones of the Programming Research Group (P.R.G.), Oxford University, ably chaired the group's meeting at Grenoble. The meeting took the form of reviewing current developments and discussing some of the promising approaches. P.R.G. are still hoping to hold a course on formal techniques early in the New Year; please contact Michael Goldsmith at P.R.G. if you are interested. I hope to arrange another meeting at Sheffield in March.

To give a general idea of the scope of the group, and as it is some time since I filed a report, here are my views: This amorphous group aims to proclaim the specific advantages of the occam/C.S.P. model of concurrency, and the broad range of application of formal methods such as concurrent performance analysis, program transformation, and the derivation of proofs. The main obstacle to the use of parallel systems needs to be overcome before their use will become more widespread. This extra burden can be regarded as 'process management' and, just as concepts like 'virtual memory' have geatly simplified memory management, so the use of occam (and the automated tools to support it) can hope to ease the explosion in complexity inherent in parallel systems. Hopefully the group will enable such grandiose aims to come to fruition.

PRODUCTS AND SERVICES

Product news from Transtech

TSMB-16 Transputer Module Motherboard

The Transtech TSMB-16 is a double eurocard motherboard, with sites for upto 16 transputer modules, giving super-mini performance at micro prices.

The TSMB-16 is compatible with Transtech's TSM42 and TSM82 transputer modules, enabling systems to be built with 1 to 16 transputers on just one board. Larger systems can be built by linking more TSMB-16 boards together or by connecting other standard transputer boards. To enable new and existing transputer users to quickly use the TSMB-16 system, the motherboard has been designed to fit into the Transtech TRANSRACK or the Inmos ITEM rack. The board can also be used standalone with a suitable power supply and mounting hardware. The TSMB-16 has sites for 2 IMSC004 link crossbar swithes, enabling the transputer links to be electronically reconfigured.The board is supplied with software to drive the C004's and set up standard transputer topologies. One link from eight of the module sites can be switched to a backplane connector rather than the C004's enabling the user to connect to other transputer boards.

The TSMB-16 also has 2 RS232 ports which can be used to connect the transputer network to peripherals. These ports also allow the system to be connected to a VAX or Sun workstation.

TSM42/82 Transputer Modules

The Transtech TSM42 and TSM82 transputer modules offer the suer a low cost transputer board system, without sacrificing any of the advantages of the transputer.

The TSM42 modules arre based on the IMST414-20 transputer and either 256KByte or IMByte of fast 100ns DRAM.

The TSM82 modules are identical to the TSM42 modules except that they have the

IMST800-20 floating point transputers.

The Transtech transputer modules have been designed to be used with the Transtech TSMB-16 transputer module motherboard to enable the user to build transputer networks with electronic reconfiguration of the links. They can also be used on their own, connected to a Transtech TSB04 board, Inmos B004, or any standard transputer hardware.

Transputer Graphics

Transtech devices will have three different transputer based graphics boards/systems available during February.

STOP PRESS:- Niche Technology have appointed Transtech Devices as sole UK agent.

Due to numerous requests for suitable FORTRAN software, Transtech has produced a support system for Micro Soft FORTRAN to run on arrays of transputers.

Transtech Devices Ltd., Unit 3, St. Johns Estate, Penn, Bucks, HP10 8HR; tel, 049481-6681.

Product news from Sension

Increased production rates and lower component costs have allowed Sension to cut the cost of its well established transputer evaluation system (TES) to around half price. A desktop evaluation system which is hosted by an IBM-compatible PC or the RM Nimbus is now available from only £1365.

The recent introduction of the Parallax system, first shown at the last OUG meeting in Grenoble, provides a convenient upgrade path for users who wish to progress from transputer evaluation to the development of applications. The Parallax system is a modular computing engine which is intended to cater for widely differing requirements: components can be built into localised or distributed systems, ranging from a few to many hundred processors.

The Parallax system is based around 19 inch subsystem modules which contain up to five computing cards. Any number of subsystems can be grouped into a single housing or can be separated by up to 500 metres by using a fibre optic data link.

Each subsystem has its own power supply, internal cooling and system management. The subsystems hold five double-height extended Eurocards which connect to a backplane through 96 or 64-way DIN plugs. Because the level of processing, storage and I/O capabilities depends upon the choice of cards, subsystems can be individually tailored to suit specific tasks.

Typically, a small development system with seven transputers, 10 Mbytes of DRAM, a graphics card, full system management facilities and occam-2 software would cost around £15000. A range of processing and storage cards are available, based on both T414s and T800s.

Currently, the basic processing element is a twin-transputer low memory card running at a clock speed of 20MHz. Each transputer is independent and is equipped with 1 Mbyte of DRAM, and all serial datalinks are brought to the backplane. Future processing cards will be available with up to eight transputers.

The complementary storage element has a single transputer and is currently fitted with 256 kbyte ZIP packages yielding 4 Mbytes of DRAM with full parity generation. It is anticipated that 16 Mbyte storage cards will be available shortly.

As well as impressive computing performance, the system has wide I/O capabilities. An industry-standard bus allows the system to use frame grabbers, graphics cards, disk controllers etc. By using a transputer driven motherboard with G64/96 compatibility, the full range of G64/96 cards can be accessed. The system also supports other bus structures, including VME.

To cater for real-time applications where it is necessary to separate processing modules from control facilities, each subsystem is equipped with RS422 drivers which maintain communications over 10-15 metres. By using an extender card and a fibre optic link, it is possible to transmit system management information and maintain signal and data integrity over distances of 500 metres.

The design of the Parallax system allows it to be used as a stand-alone unit or hosted by a PC. During system development, components can be readily restructured and any IBM-compatible can be used as a user interface and control station. In a real-world application, the system can be reconfigured to be self-hosting and all connections reinforced by wire-wrapping. Envisaged applications include modelling, trend analysis, real-time control, graphics, CAD/CAM and massive database manipulations.

The system is available with the usual occam-2 development software and debugging facilities. New software includes a range of compilers, catering for Fortran 77, Pascal and C. The compilers are currently available only as single transputer versions, although multi-transputer compilers are imminent.

Sension supplies all transputer hardware and software products with full technical support and consultancy facilities. The transputer engineering team also offers a custom design service for dedicated applications systems and their associated software.

For further information, telephone Mark Sykes on +44 606 44321.

Product news from Niche Technology

Niche Technology Ltd (Niche Data Systems Inc. in the USA) offer a product called the Advanced Computing Platform (ACP), which plugs directly into the standard Sun/3 or Sun/4 chassis and offers up to 320 MIPS or 48MFLOPS. With a Sun 12-slot chassis able to accommodate up to 8 platforms, a maximum of 2.5GIPS or 384MFLOPS is possible.

The platform operates under the SunOS Unix operating system, with interfaces to facilities such as NFS, NeWS/X.11, and SunView, as well as the main Unix System V/BSD 4.2 services. The NT1000 is a motherboard which plugs into the Sun/3 VME bus, offering a range of I/O interfaces plus sites for up to 32 computing modules. One intelligent high-speed multiport controller, and five low-cost medium- speed ports are made available.

An extensive range of plug-in compute modules is available. Each consists of a 10MIPS / 1.5MFLOPS transputer combined with up to 16Mbytes of fast local memory. The transputer networks are software-configurable. Device drivers within the host operating system enable transparent multi-board capability, while edge connectors provide interfaces to external equipment.

Software includes TDS for occam2, and compilers for Fortran, C, and Pascal. Sun drivers and servers are available.

One-up prices for Platforms start at £2250, and Modules at £650, with the TDS software offered at £1453.

Further information may be obtained from +44 272 298034 (UK), and +1 713 751-0055 (USA).

Product news from Fast Filters

DAT 650MB Archive Interface

The FF DAT650 board allows Transputer system users to interface to Digital Audio Tape machines and CDs. Each 120Min DATtape is capable of storing over 650MBytes of data. Read and write transfer rates are both 192KBytes per second, or approximately 10MBytes per minute. Fast random accesses are not supported! The FF DAT650 was designed for Transputer based Digital audio systems. Other applications include archiving large volumes of non-critical data, industrial process monitoring, medical applications, image storage, product demonstrations and data acquisition systems, etc.

The Fast Filters DAT650 will be available from April 1988 at a cost of £495.

FF1000 Digital Filter

The FF1000 digital filter board may be configured to perform a range of different filter functions including long FIR filters. An onboard DSP processor, the IMSA100, is used to achieve 1000 tap FIR filters with 50 kHz throughout. All I/O and control is via links. Contact Fast Filters for details of price and availability.

Fast Filters, 1 Cole Road, Bristol, BS2 OUG, Tel: 0272 723165

Course: Occam 2 and the Meiko Surface

University of Edinburgh

This course is aimed at those with little or no previous experience of occam and the INMOS transputer. It will enable participants to write applications software for a range of advanced transputer-based systems.

Course dates: 23-25 March, 1988 and 29 June- 1 July, 1988.

Enquiries to: Edith Field, Unived Technologies Ltd, 16 Buccleuch Place, Edinburgh, EH8-9LN. Tel: 031 667 1011 ext. 6742.

OCCAM 2 AND TRANSPUTER ENGINEERING

Computing Laboratory, University of Kent at Canterbury

Course Objectives: To acquire technical knowledge, insight and practical experience of *parallel system design* using occam and transputer networks. Software engineering principles, load-balancing techniques, real-time applications and various embedded and super-computing issues will be covered.

Course Members: Engineers with *some* experience of a traditional "high-level" language. *[Note: we have found that hardware engineers, with only a modest knowledge of software, find the occam concepts for parallelism particularly easy to master.]* Since September 1986, this course has attracted over 100 participants from Industry and Academia worldwide.

Course Methods: Informal lectures with a large proportion of "hands-on" experience being provided through practical exercises and a "mini-project". Practical work will be on the MEiKO† Computing Surface† and will be supervised at the ratio of one tutor for every six attendees. The MEiKO provides a multi-user multi-transputer development and applications environment. Our system will support up to 16 simultaneous users, each with dedicated access to a private network of transputers including at least two T800s. The full system comprises over 80 transputers (including 55 T800s) with a gigabyte distributed file store and three high resolution graphics workstations.

Length & Cost: Five days & £375 per person (*inclusive* of lunches, coffee, tea and biscuits).

Dates: *Course No. 8*: 4 - 8 July, 1988.
Course No. 9: 26 - 30 September, 1988.

Contact: For a full syllabus, application forms, special arrangements and accommodation, please contact Dr. P H Welch, Computing Laboratory, The University, Canterbury, Kent, CT2 7NF (*Tel*: 0227-764000 ext. 3629) (*email*: phw@uk.ac.ukc).

Technical Notes Available From Inmos

0 A Transputer Based Radio-Navigation System 72-TCH-000-00
Design of a LORAN (Long-range Radio Navigation) system using a 16 bit IMS T212 transputer and link adaptor.

1 Extraordinary use of Transputer Links 72-TCH-001-00
Examples of procedures for recovering from communication failures through link connections

2 Testing Embedded Systems - Transputer Navigation System 72-TCH-002-00
Demonstrates a method of testing the LORAN design in Tech Note 0.

3 Getting Started with TDS 72-TCH-003-00
How to install the IBM PC XT/AT version of the Transputer Development System (IMS D701-4) and how to enter, compile and run a simple occam program

4 TDS EPROM Programming 72-TCH-004-00
How to create PROMs suitable for booting a transputer or network of transputers, using the tools supplied with the IBM PC version (IMS D701-4) of the transputer development system

5 Program Design for Concurrent Systems 72-TCH-005-01
Illustrates one approach to programming concurrent systems in occam. It concentrates on applications rather than general purpose computer networks

6 IMS T800 Architecture 72-TCH-006-01
Overview of the architecture and features of the IMS T800 32 bit floating point transputer

7 Exploiting Concurrency: A Ray Tracing Example 72-TCH-007-00
Describes the implementation of a computer graphics program on an array of transputers

8 IMS B010 NEC Add-in Board 72-TCH-008-00
Describes the design of a transputer system to interface to the NEC PC and to run the transputer development system

9 Designing with the IMS T414 and IMS T800 Memory Interface 72-TCH-009-01
Describes the use of the external memory interface of the T414 transputer to interface a variety of memory types

10 IMS B003 Design of a Multi-Transputer Board 72-TCH-010-00
Description of the features and configuration of the IMS B003 evaluation board

11 IMS B004 IBM PC Add-in Board 72-TCH-011-00
Description of the features and configuration of the IMS B004 IBM PC XT/AT add-in evalution board

12 IMS B007 A Transputer Based Graphics Board 72-TCH-012-01
Describes the implementation of a high performance, medium resolution graphics hardware system based around the IMS T414 transputer

13 Transputer Networks using the IMS B003 72-TCH-013-00
Describes several arrays of transputers that can be configured with the IMS B003 evaluation board

14 IMS B006 A Single Board Computer 72-TCH-014-00
Describes the IMS B006 evaluation board. The B006 enables the user to evaluate multiple transputers

15 IMS B005 Design of a Disk Controller Board with Drives 72-TCH-015-00
Describes the design and features of the IMS B005 evaluation board using the IMS M212 disk controller

16 Occam Program Development Using the IMS D701 TDS 72-TCH-016-00
Gives an overview of the facilities provided in the transputer development system for the writing, compilation and running of programs written in occam

17 Performance Maximisation 72-TCH-017-00
Discussed maximising the performance of an individual transputer, and maximising the performance of arrays of transputers

18 Connecting INMOS Links 72-TCH-018-00
Describes the operation of the INMOS Link protocol along with several hardware design examples to include a design using fibre optics

19 Designs and Applications for the IMS C004 72-TCH-019-00
Describes the C004's functionality, how it may be used as a design element to provide larger crossbar switches, and how it may be applied to configure large transputer networks

20 Communicating Process and Occam 72-TCH-020-00
Describes how the occam programming language enables an application to be described as a collection of processes which operate concurrently and communicate through channels

21 The Transputer Implementation of Occam 72-TCH-021-00
This demonstrates how the transputer can be used as a building block for concurrent processing systems, with occam as the associated design formalism

22 Communicating Process Computers 72-TCH-022-00
Describes the construction of computers based on communicating process architecture

23 Compiling Occam into Silicon 72-TCH-023-00
Describes how a communicating process language such as occam can be used in the design of VLSI devices

ARTICLE

GOTO (CONSIDERED HARMFUL)^n, n IS ODD

P.H.Welch, Computing Laboratory, The University, Canterbury, KENT — CT2 7NF

SOME CORRESPONDENCE

You have either been following, or else have just missed, an entertaining series of letters in the columns of the *Communications of the ACM*. The subject was the *GOTO* statement and its contribution to simple clear programming. The debate was passionate. For an *occamist*, it was somewhat alarming to see all those *GOTOs* rising to the surface with such vigour. Just when we thought it was safe to commit ourselves to working with a language that didn't have the things, there they were again demanding attention and threatening to bite!

It started with a serious letter [0] in the March 1987 *CACM*. This argued that a literal acceptance of Dijkstra's 19 year old letter to the same journal, "GOTO Statement Considered Harmful" [1], leads to gratuitously contorted, inefficient and often incorrect algorithms. The author described his astonishment at the almost universal acceptance of Dijkstra's proposition — the points in its favour being merely "academic" — and claimed that this had cost the software industry "hundreds of millions of dollars in excess development and maintenance costs, plus the hidden cost of programs never developed due to insufficient resources"!

Whilst the author agreed that unbridled use of the *GOTO* was a bad thing, he maintained that it was quite safe — indeed, most beneficial — to give yourself the occasional fix to get out of some logic into which you had gotten yourself jammed. Moderate use of the *GOTO*, therefore, was a good thing, gave much needed relief and would not turn you into a hardened addict.

In order to illustrate this thesis, the following problem was specified. "Let *X* be an *N* x *N* matrix of integers. Write a program that will print the number of the first all-zero row of *X*, if any".

That letter stimulated an enormous response (see the May, June, July and August *CACMs*). Clearly, there were a lot of people out there nursing large grudges against the accepted wisdom that forbade them the *GOTO*. Numerous "solutions" were offered, both with *GOTOs* and without. Many contained errors (chiefly array index violations, but also failing to work if the all-zero row was the last one, if *N* were zero or other silly end effects that are the cause of so many software problems). Virtually no attempts were made to reason — even informally — about the correctness of the algorithms.

Eventually, Professor Dijkstra responded [2] and pointed out the obvious: that the set problem is a double instance of a standard problem (the "bounded linear search") for which there is a standard algorithm (involving a while loop, indexing and a boolean flag) and a standard theorem to prove its correctness. To solve the problem, do a bounded linear search through the rows of the matrix seeking an all-zero row. To seek an all-zero row, do a bounded linear search through its elements looking for a non-zero. Correct code is produced by applying the theorem twice with no further proofs necessary.

The trouble is that people look at Dijkstra's code in isolation from its derivation and say: "Crumbs, I can't follow that — I still prefer that *GOTO* solution as being snappier and more direct." This is despite the fact that we don't really need to look at Dijkstra's code and understand it, since it was generated automatically (i.e. we may consider it as "object" code, not really for human consumption). It seems that we have a psychological need to look at real code, feel comfortable about it and not rely on those funny "academic" theorems.

BUT IN OCCAM ...

In *occam*, of course, we have no choice — there is no *GOTO* to tempt us from the true path. But the true path now offers complete relief since *occam* allows a direct algorithm to implement the bounded linear search (that is far simpler than the standard one employed by Dijkstra and has a trivial correctness proof).

Let's formalise the specification (just a little bit). The "bounded linear search" is simply to find the smallest *i* from the set *{0, ..., n−1}* such that some predicate, *P(i)*, holds — if any. The simple solution is to test the predicates *P(0), ..., P(n−1)* sequentially until one holds or they all fail. This, of course, is directly expressed as a single *IF* statement :-

```
IF
  P(0)
    ... answer is 0
  P(1)
    ... answer is 1
  .
  .
  P(n-1)
    ... answer is n-1
  TRUE
    ... search fails
```

The correctness of this implementation follows directly from the semantics of the *IF* construct (which evaluates its conditions sequentially until one turns out to be *TRUE*).

For variable *n*, *occam* has a syntactic abbreviation for this lengthy (but trivial) statement :-

```
IF
  IF i = 0 FOR n
    P(i)
      ... answer is i
  TRUE
    ... search fails
```

(Note that if *n* is zero, the inner *IF* clause replicates zero times and the *search fails* — no "silly bugs" here!)

To the *occamist*, this is elementary stuff. There is nothing clever here — that is the important point. There is a sense of wonder that anybody would wish to employ some *WHILE* loop with tricky flag variables — let alone anything so insecure as a *GOTO*!

To solve the set problem, there are two nested bounded linear searches. The inner search checks on a particular row :-

```
BOOL FUNCTION all.zero (VAL []INT row)
  BOOL answer:
  VALOF
    IF
      IF j = 0 FOR SIZE row
        row[j] <> 0
          answer := FALSE
      TRUE
        answer := TRUE
    RESULT answer
:
```

The main search then becomes :-

```
BOOL, INT FUNCTION first.all.zero.row (VAL [][]INT X)
  BOOL found:
  INT index:
  VALOF
    IF
      IF i = 0 FOR SIZE X
        all.zero (X[i])
          found, index := TRUE, i
      TRUE
        found, index := FALSE, -1
    RESULT found, index
:
```

This completes the solution. I would claim that it is clear, correct and trivial — indeed, more so than any incorporating a *GOTO*. But that, of course, is a subjective claim.

SECURITY AND EFFICIENCY

Three points about *occam* to forestall some criticism of the above code. Firstly, *VAL* parameters may be passed by value or reference or in-line name substitution (no assignments to or aliasing of them are allowed by the language — these are enforced by the compiler). The *transputer* implements vector parameters by reference — i.e. we get both security and efficiency (*occam FUNCTION* parameters must be *VAL* data types).

Secondly, although the final *RESULT* clause of the *VALOF* expression forces explicit declaration of some transient variables (e.g. *answer*, *found* and *index*), its compulsion enables the compiler to check that *FUNCTION* results do get defined — i.e. we get security at the cost of some mild inconvenience. Not allowing the arbitrary placement of a *RESULT* clause also prevents its use as a sneaky break out of loops within *FUNCTION* bodies (as if you ever thought of trying such a thing!).

Thirdly, an objection was made in some of the *CACM* correspondence to the abstraction of the *all.zero* logic into a separate *FUNCTION.* I would have hoped that such thinking would have been abandoned long ago as counter-productive. However, if people really worry about this, *occam FUNCTION* calls are defined semantically in terms of their in-line substitution. The transformation which removes this abstraction is trivial and precisely defined in the language definition [3] (and may be done by compiler optimisers).

In summary, we have a simple, clear, complete and efficient solution in a simple, clear, complete and efficient language.

In the August *CACM*, the author of the original letter renewed his challenge: "It is easy to find problems where the best known solution with *GOTO*s permitted is simpler and/or faster than the best known solution with *GOTO*s forbidden. The opposite is impossible"! With *occam*, we can refute this and we can do so using his own problem.

SUMMARY

Occam is a rare programming language in that it obeys (and was designed to obey) a rich set of simple mathematical laws [4, 5]. This allows clear thinking.

In all the excitement about *occam*'s power for expressing parallel logic, we should not underestimate its contribution for sequential reasoning. For instance, the fact that expression evaluation is mathematically pure (i.e. no side-effects can take place), whilst offending the hardened *C* hacker, does lead to code that can be reasoned about. [It also would permit a parallel implementation of expression evaluation ... but that is quite another story!]

This article has pointed out how a standard *occam* sequential construct (the replicated *IF*) gives a trivial solution to a standard old problem (the bounded linear search) which is frequently raised to support the contention that *GOTO*s are needed for simplicity and efficiency. [Actually, if anyone knows of another use for the replicated *IF*, please tell me!!]

CONTENTIOUS FOOTNOTE

Many of my colleagues are getting excited about the impending arrival of robust *C* and *FORTRAN-77* compilers for the *transputer*. "At last,", they say, "*transputers* we can use!".

This puzzles me. I see such developments only for providing necessary short-term solutions to enable existing software take advantage of (single) *transputer* performance. For instance, individual alien-language jobs could profitably be submitted to some batch-processing *transputer* "farm". However, I would not want to use *C* as the implementation language for the farm software.

For anything new, I want to use *occam* to program *transputer* networks because :-

- the *occam* model of concurrency is simple, powerful, mathematically consistent and built into the language as a central feature of its original design;
- the *occam* model of sequential logic is simple, mathematically consistent, certainly safer and, in some ways, more powerful than those of traditional sequential languages.

I have little trust in, and no enthusiasm for, traditional sequential languages to which parallel constructs have been grafted as an afterthought. The *occam* approach enables a comprehensive view to be developed of a concurrent system as a single integrated software/hardware structure.

So, the next time anyone offers you a quick *GOTO* and an alien language — just say: "... go replicate an *IF*!".

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BOOK AND ARTICLE REVIEWS

The Editors welcome the contribution of books and articles for consideration in this section. We intend starting the reviews in the next issue of the Newsletter, therefore, contributions should be sent as soon as possible to the editors (address on back page).

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