VISIT TO ICOT
6–13 May 1992

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I visited ICOT for one week, in order to discuss certain topics of joint research interest with members of the 5th Research Laboratory and to help prepare a demonstration for FGCS'92 using their theorem prover MGTP. Dr Mark Grundy of the Centre for Information Science Research accompanied me on this visit and will remain, to work on the demonstration software, until FGCS'92 next month.

We were provided with the same working environment as an ICOT researcher, with PSI workstations having good local area connections to other ICOT machines. Using email was possible, and through ICOT 34 the Internet was available for remote contact with ANU and other sites. Dr Grundy spent most of the first two days setting up our computer environment to be as much as possible like that we use in Canberra. The availability of X Windows was useful in this regard. I was able to start transferring and installing software very soon after arriving at ICOT. I did not myself use the parallel machines, though we do intend to take results probably from PIM-M for our demonstration.

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I used the Internet to bring several existing programs from Canberra and installed them here at ICOT. The first program was FINDER, which generates finite models for sets of first order clauses. FINDER is written in C and intended to run under Unix. The second C program was MaGIC, similar to FINDER but specialized to generate models of non-classical propositional logics. There were no problems with installation on a PSI machine (PSI/UX 5.5). I also installed them on a Symmetry (ICOT 34), where there were no serious problems, although for a while the /home disk became full. These programs are in the public domain. I hope that they may be of use to researchers at ICOT in the future. Full documentation is available in the TR-ARP technical report series from ANU, and some ICOT researchers already have these documents.

The program I worked on here was SCOTT, a variant of the theorem prover OTTER from Argonne National Laboratory, Illinois. SCOTT is closely related to the software we intend to demonstrate at FGCS'92, except that it uses FINDER to generate models where we hope to use the more intelligent program MGTP for the demonstration. I did not succeed in installing SCOTT on the PSI machine because some library functions used by OTTER for timing were unavailable. I did not investigate this problem at all, but simply installed SCOTT on the Symmetry instead and worked with that.

Following a suggestion of Dr Fujita, I began to investigate the effect of using a model generator to delete unreachable goals from hyper-resolution proofs in the OTTER style. The proof idea is to add goal literals to the input for hyper-resolution proofs, adding for each predicate p a corresponding goal predicate gp subject to the condition that $p(x)$ and $gp(x)$ constitute a contradiction. Then instead of a negative goal $-p(t)$ we may stipulate $gp(t)$. This allows further goals to be deduced during the proof search. In some cases this will clearly be valuable, as one of the deduced goals may be matched before the main goal. Now where we have models of the theory (minus goals) we can delete any derived goal $gp(t)$ if the models show $p(t)$ to be underivable from the theory. This increases proof search efficiency. I implemented this idea in SCOTT and did a few experiments on some condensed detachment proofs for problems in pure implication calculus. The results were interesting but a little disappointing. In each case, all of the derived goals were deleted! This shows that derived goals are not a useful proof technique for that particular problem set. Further research into the idea is indicated.

Following discussions with Dr Fujita and Dr Grundy, I added to SCOTT a facility to create a log file recording the behaviour of the prover in response to the semantic filter. This was not a difficult piece of programming. We expect that the similar system using MGTP will be able to dump a corresponding log trace so that postprocessing analysis (perhaps including animations) can be performed. Such a facility will be useful in research as well as for the FGCS'92 demonstration.

I demonstrated and explained the semantic resolution prover to several researchers including M. Fujita, H. Fujita and Dr Hasegawa. I also discussed the algorithm in some detail with my colleague Dr Grundy who is to do most of the programming for our FGCS'92 demonstration.

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During the two weeks immediately prior to my visit I had been in frequent email contact with Dr Fujita Masayuki. He has performed experiments using MGTP to generate finite models for several of the cases in which I had used FINDER. It should be made clear that the two programs use totally different algorithms, so comparison of their behaviour is quite instructive. It was found that MGTP is extremely efficient in the case of some problems concerning quasigroups. It was used to show that there is no quasigroup of order 10 satisfying the equation $(yx.y)y = x$. This had been left as an open problem by F. Bennett in a paper in the *Canadian Journal of Mathematics* in 1989, and so far as we are aware was still an open problem until solved by MGTP. Some related problems, of showing that there is no idempotent model of order 9 or 12, were also solved by MGTP, though the result for order 9 quasigroups was already known. FINDER was unable to solve these problems, except for the idempotent case of order 9, which is the easiest. This application to finite algebra is very exciting, and we intend to pursue it further. As a result of my visit to ICOT, I have a better

idea of how MGTP manages to make its search strategy so efficient. I shall now attempt to bring something of the same strategy into the different kind of model generation algorithm represented by FINDER. We shall also investigate ways of applying MGTP to similar problems in finite algebra. There are extremely difficult problems in finite projective geometry, for example, which may be suitable for MGTP. More generally, the relationship between reasoning in MGTP's manner and backtracking search in the style of FINDER is still in need of more research.

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I wish to conclude this brief report by expressing appreciation for the work of those people at ICOT who organised my visit, and that of Dr Grundy, at rather short notice. Dr Iwata Kazuhide and his assistant Karakawa Kumiko of the Research Planning Department arranged all that was necessary, welcomed us to ICOT, looked after our needs and made it possible for us to concentrate exclusively on our research. I myself have been responsible for arranging visits by overseas researchers to Canberra, so I know that this work is not trivial. Among the researchers, we worked most closely with Dr Fujita. He gave his own time generously to help with our project, and also acted as our host outside working hours. We do appreciate that.

This was my first visit, not only to ICOT but to Japan. My only regret is that it had to be so short.

John Slaney
1992 May 12

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A. Personal Details

Name:	John Keith SLANEY	
Date of birth:	18 November 1953	
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B. Education

Undergraduate:	King's College University of Cambridge	1973–1976
	Examinations: Philosophy Tripos Ia. Class: I Philosophy Tripos Ib. Class: I Philosophy Tripos II. Class: I	
	Degree: B.A. (1976) M.A. (1980)	
Postgraduate:	Australian National University	1977–1980
	Thesis: Computers and Relevant Logic: a Project in Computing Matrix Model Structures for Propositional Logics	
	Degree: Ph.D. (1980)	

C. **Employment**

1980–1981	University of Durham Department of Philosophy	Postdoctoral Scholar
1981–1982	St. Andrews University Department of Logic & Metaphysics	Lecturer (temporary)
1982–1983	University of Queensland Department of Philosophy	Postdoctoral Fellow
1983–1990	University of Edinburgh Department of Philosophy	Lecturer (tenured)