

SCIENCE AND ENGINEERING RESEARCH COUNCIL
RUTHERFORD APPLETON LABORATORY

INFORMATICS DIVISION

SOFTWARE ENGINEERING GROUP NOTE 74

issued by
R W Witty

SEG ANNUAL REPORT
September 84-September 85

30 September 1985

DISTRIBUTION: R W Witty
 D A Duce
 F M Russell
 C P Wadsworth
 A J J Dick
 E V C Fielding
 A D B Cox
 D C Findley
 D R Gibson
 P M Hedlund
 F R A Hopgood
 C J Pavelin
 M R Jane
 K Robinson
 R E Thomas
 D E Talbot

KEYWORDS: SEGN 74 SEG Annual Report

(see next page)

1. THE ROLE OF THE SOFTWARE ENGINEERING GROUP

SEG's role is fourfold

- (1) Alvey SE Programme management, ie the 'Millbank' function, with special responsibility for the academic SE Component, SERC/RAL finance and CO liaison.
- (2) Technical Support to the Alvey SE Programme. This involves advice to the Millbank staff on technical issues (eg Wadsworth's briefing to Oakley on Japan), compilation and distribution of the SE Mailshots, refereeing project applications, information gathering (eg cellular radio, 3270 emulation).
- (3) Development work on behalf of the Alvey SE programme. This can be on behalf of specific projects (eg BSD 4.2 Ring driver for Newcastle/Aspect) or for the Alvey SE 'infrastructure' generally (eg Perq Ring driver, Newcastle Connection). Some Development work of the 'specific project' variety will be on behalf of SEG's own research projects (see below).
- (4) SE research, in line with Alvey SE strategy IEC/CSC policy and in collaboration with industry, GREs and Universities.

Management, Technical Support and Development work are funded 'directly' from Millbank to SERC/RAL. They attract 75% DTI funding because these activities are services on behalf of both academic and industrial communities.

The research work is funded differently. This must either follow normal Alvey rules, ie a complete, collaborative project must be constructed, approved and awarded or go through the peer review system of IEC/CSC. At any given instant SEG aims to have more than one project underway with successors in the pipeline. SEG aims to have both Alvey and CSC funding simultaneously because some work will be more suited to CSC.

2. ALVEY SE PROGRAMME MANAGEMENT

2.1 SEG's Contribution to Alvey Management

The software engineering component of the Alvey Programme is a significant part of the total, amounting to about £40M (£65M total), of which about £16M is for the academic part of the SE programme. An existing portfolio of academic research grants in SE (the SERC's Software Technology Initiative) has been included in the Alvey Programme to ensure continuity and involvement of all relevant SE research in the UK. At present the SE programme consists of 47 new academic awards, of which 11 are fully collaborative with industry. There are 15 new awards, many of them collaborative, being processed by SERC Central Office to be offered shortly. Additionally, the existing portfolio contained 40 projects of which 23 are still running.

Support for the Alvey Programme consists of interaction with academic groups to assist in the preparation of grant applications and coordination of the SERC/Alvey Directorate interface.

Research supported by Alvey differs from that usually supported by SERC in that the Alvey Programme is a directed programme. This involves much closer involvement in both the preparation of the grant applications and especially during the execution stage of the research. For this purpose all projects are monitored, both technically and financially. This involves preparation of a database on all projects, collation of reports, generation of summaries and spend profiles. Regular reports are required from Monitoring Officers for collaborative projects and from industrial Uncles for academic only projects. Any exceptions raised by this monitoring process are actioned quickly.

Support is provided also for the Alvey SE Office in Millbank by providing assistance in meetings, workshops, panels and presentations. Much effort is expended in maintaining the files and reporting procedures for the programme. To assist in maintaining continuity of research, a mailshot service is operated. An increasingly important aspect of the overall support as the programme develops is the analysis of the budget and preparation of data for forward planning. For this purpose a special procedure has been developed with the objective of minimising difficulties associated with over commitments of the budget.

R W Witty, F M Russell and D C Findley, supported by Lilian Valentine and Janice Gore, undertake the above work.

As Deputy Director of the Alvey SE Programme RWW has responsibility for the overall strategy of the Programme, its infrastructure policy and the general academic contribution. He has contributed to the cooperation being built up between Alvey and the EEC, France and the USA.

2.2 ACARD WG on SE

ACARD (the Advisory Council for Applied Research and Development) is a high level body which reports to the Cabinet on long term issues. ACARD is currently studying the state of the UK software industry, its future prospects and the role of software engineering in all aspects of UK industrial activity (ie Manufacturing and Services).

The study is being conducted by a working group chaired by John Coplin, the Design Director of Rolls Royce. RWW, through his Alvey role, is a member of this working group.

The study has been conducted on a part time basis for much of 1985 and a report is likely to go to the Cabinet in 4Q86.

3. ALVEY SE TECHNICAL SUPPORT AND DEVELOPMENT WORK

3.1 Introduction

The period has been one of transition as the section completes previous involvements arising from DCS, STI and the Common Base and begins to build up its new research links. Day-to-day activities have concerned the completion of Cambridge Ring developments, conversion of ML/LCF to the new Standard ML, and the import and evaluation of theorem-proving tools both for our own use and on behalf of the Alvey SE infrastructure.

3.2 Theorem Provers

Theorem provers are software tools to aid the process of proving theorems. In this context we are primarily concerned with theorems about programs, for example that a particular program possesses a particular property. Three current systems, ML/LCF, IOTA, and Boyer-Moore, have been acquired and are being studied to varying degrees. A fourth system (Gypsy) that we would like to know more about is not available owing to a US embargo!

The Cambridge version of ML/LCF was mounted on RLVC and then ported to the Atlas 10 under UTS (ADBC and A J Kinroy before he left). The UTS version has demonstrated the benefit of mainframe power for large proofs and is already being used so by external researchers at Cambridge. Proofs that previously would have been run overnight on a VAX are now accomplished in terms of minutes on UTS.

IOTA is a modular programming system, built in Japan, which includes a significant verification capability and has many features of a prototype second-generation Alvey IPSE. Experience with the approach will be of particular value for the IPSE 2.5 project.

Investigations have continued into how best to make IOTA available in the UK. IOTA is implemented in an ancient dialect of Lisp which turns out to be a forerunner of PSL (Portable Standard Lisp). PSL runs on a variety of machines (DEC20, VAX, Apollo) and has now been acquired for VAX Unix. An assessment is being made of the work required to port IOTA to run on top of PSL. A few problems have inevitably been encountered but are gradually being resolved.

The latest version of the Boyer-Moore theorem prover has been obtained from the University of Texas. We have yet to work with this system ourselves but are acting as a UK distribution point. The system has been distributed to about a dozen industrial and university sites.

3.3 Standard ML

The section has actively followed the development of the new Standard ML. CPW attended the Edinburgh meeting in May to finalise the language. The standard is a consolidation of tried-and-trusted developments in the ML community since the original language was designed for the Edinburgh LCF project. Principal additions are: the data constructors and pattern matching facilities of HOPE, exception values, a richer and more systematic set of definition constructs, a module facility based on the latter, and I/O handling. Final documentation from Edinburgh is awaited. The language has Alvey backing and we expect to use it for our theorem proving work.

PMH joined the group in January and has been working on converting ML/LCF to Standard ML. The new parser and typechecker are complete and he is now working on the rest of the system (code generator and run-time support). It will remain then to transliterate the 20 or so LCF sources files written in old ML to Standard ML. The aim is to ensure that LCF, as the largest application of ML to date, is fully available for Standard ML. (The modules facility is not needed for LCF and is not being implemented in the first instance.)

3.4 Cambridge Ring

The plan for SEG infrastructure envisages a variety of Unix systems linked by Newcastle Connection. It was felt that SEG could achieve this quickest by using the Ring since we had one in place and common interest and a common machine range with Newcastle. A lot of effort has been consumed in the attempt.

Perq BBP was at last completed, the VAX driver converted to BSD 4.2 (by Unix Systems section), and the LSI11 BBP driver has been upgraded to CR82 standard (by DRG). A simple file transfer program that runs directly over BBP was quickly implemented (by DRG) and tested successfully between Perq, VAX, PDP11, and LSI11. The program provides file transfer similar to Perq PUFTP, with a fivefold increase in throughput (despite the slowness of Perq BBP!).

Release 1.1 of the Newcastle Connection for PDP11 was finally received after months of contractual wrangling and installed on the PDP11/34 and LSI11/23. DRG did sterling work assessing the installation and feeding the results back to Newcastle.

The Perq, VAX and LSI11 drivers were supplied to Newcastle to enable them to upgrade the Connection where necessary for interworking between dissimilar hosts. This has not had the expected results! Hopes of a distribution for interworking Perq, VAX and PDP11 over the Ring have evaporated into the Ether (to coin a phrase). So near and yet so far.

4. RESEARCH

4.1 Introduction

The overall SEG research theme is "Quality Certification of Software Products". Within this theme, the main research interest of the Group is in Formal Specification, the development and application of machine-assisted proof systems and the role of formal proof in software development.

4.2 Formal Specification

David Duce and Liz Fielding hold a research grant under the Alvey Software Engineering Programme entitled 'Specification of the Graphical Kernel System (GKS)'.

GKS became an ISO standard on 15 August 1985, and has been a British Standard for some time. The document describing GKS is some 245 pages in length; the style of the description is mainly English narrative. It is difficult for a potential implementor to get to grips with the standard from this document. There is a major effort in Computer Science research to develop formal techniques for the description of system designs; the aim of this project is to apply such techniques to GKS.

Initial work has been carried out with the Vienna Development Method (VDM), and more recently comparative studies with other formal techniques have been started. This work has resulted in a number of publications.

A complementary activity, looking at the emerging 3D Graphics Standards, GKS 3D and PHIGS, has been approved by SERC's Computer Science Committee.

Seminars on the research work have been given at:

- University of Cambridge
- University of Oxford
- University of Salford
- University of Lancaster
- University of East Anglia
- University of Leicester
- Imperial College, London
- SRI, California
- IBM, Yorktown Heights

4.3 Graphics Standards

DAD and EVCF participated in the ISO computer graphics working group meeting in July 1985. Both are involved in the formal specification subgroup. The main work of the meeting was to draft the structure of an ISO Technical report which will look at the feasibility of using formal specification techniques in the development of graphics standards.

The major landmark in graphics standards during 1985 was the publication, on 15 August, of GKS as the first ISO International Standard for Computer Graphics. DAD and Dale Sutcliffe (CCD) produced the camera ready copy from which the standard was typeset.

DAD is secretary of the BSI computer graphics panel.

4.4 Typesetting

Good typesetting facilities are essential to the smooth progress of the group's research projects, especially the Formal Specification and ERIL projects. EVCF did an excellent job in developing software to couple the Unix titroff text formatter and the IBM 4250 electro-erosion printer. The help of Chris Osland and Francis Yeung is gratefully acknowledged.

4.5 Equational Reasoning

A J J Dick's research concerns theorem-proving with equations based on a technique called the Knuth-Bendix completion algorithm. In this approach, equations are considered as rewrite-rules, and can actually be used to perform computations. There are many important applications of such work in computer science, especially in proving properties of program specifications, modelling the execution of functional programs, transforming programs into more efficient but equivalent ones, and compiling techniques.

During the last twelve months, AJJD has built on theoretical and practical work achieved as a PhD student at Imperial College. His main practical goal has been to develop further a rewrite-rule laboratory (mechanical theorem prover) called ERIL (Equational Reasoning: an Interactive Laboratory) to the point where it can be made available as a tool on the Alvey infrastructure machines; this goal is almost complete. At the same time, he has been able to considerably clarify much of the theoretical basis for ERIL, particularly with regard to a special form of polymorphism involving hierarchical types and overloaded operators. Experimenting with this has represented original research effort.

The following useful visits and contacts have been made:

A seminar given to the Programming Research Group at Oxford University, resulting in an ongoing discussion of the application of equational reasoning to program transformation.

A presentation of ERIL at the European Conference on Computer Algebra, Linz, Austria, in April, which was very well received and resulted in a further invitation:-

A three-day visit to the Centre de Recherche en Informatique de Nancy, France for an extended presentation of ERIL and its theoretical basis, combined with attendance at the conference on Rewriting Techniques and Applications, Dijon, France in May.

A two day visit to UMIST to install ERIL for their experimental use; also gave a seminar on the Knuth-Bendix algorithm as implemented in ERIL.

A presentation to the FOREST project (Alvey sponsored) at Imperial College.

AJJD holds the Atlas Fellowship which is in association with St Cross College, Oxford.

4.6 IPSE 2.5

CPW has been having discussions have been underway with potential collaborators and we hope soon to agree our first venture by joining the Alvey IPSE 2.5 project. IPSE 2.5 is a major Alvey project to build a support environments for formal methods. Our contribution is expected to concentrate on the development of the theorem-proving capability for the project and research into new approaches to proof construction designed for advanced interactive use on large, high-resolution displays.

5. DCS PROGRAMME

The DCS Programme formally terminated on 6 September 1984. The occasion was marked by a major conference at the University of Sussex. David Duce was very heavily involved in the organisation of this.

After the conference there were the inevitable tidying up activities, the major ones being the production of the DCS Final Report, disposal of the equipment pool and rationalisation of the associated maintenance contracts.

6. STAFF CHANGES

SEG welcomed the following new members during the year

Sep 84	D C Findley	- Alvey Management
Oct 84	A J J Dick	- Atlas Fellow with St Cross College
Jan 85	P M Hedlund	- Research Section
July 85	A D B Cox	- Research Section (transferred from RAL/ID/IKBS)

Alan Kinroy left us in Dec 84 to return home to his native land.

In June 1985 G P Jones left us to be promoted to the post of ID/DAO.

7. PUBLICATIONS

1. D A Duce, E V C Fielding and L S Marshall, 'Formal Specification and Graphics Software', RAL-84-068.
2. D A Duce and E V C Fielding, 'Better Understanding through Formal Specification', RAL-84-128, accepted for publication in Computer Graphics Forum.
3. D A Duce and E V C Fielding, 'Formal Specification - A Simple Example', to appear in ICL Technical Journal.
4. D A Duce and E V C Fielding, 'Formal Specification - A Comparison of Two Techniques', RAL-85-051.
5. D A Duce, 'Concerning the Specification of User Interfaces', Computer Graphics Forum 4 (1985), 251-258.
6. F B Chambers, D A Duce and G P Jones (eds), Distributed Computing, Academic Press, 1984.
7. 'Information Processing Systems - Computer Graphics - Graphical Kernel System (GKS) functional description', ISO 7942, ISO Central Secretariat, Geneva, 1985.
8. D Gibson and D A Duce, 'GKS and Text Processing', Computer Graphics Forum, 4 (3), 1985.
9. F R A Hopgood, D A Duce, E V C Fielding, K Robinson and A S Williams (eds), Methodology of Window Management, Springer Verlag, to appear.
10. D A Duce (ed), DCS Programme Final report, SERC, 1984.
11. R W Witty, Software Technology Initiative Final report 1981-84, SERC, 1984.
12. W P Sharpe, R W Witty et al, 'Alvey Directorate Infrastructure Policy', IEE, Sept 84.
13. R J Cunningham, A J J Dick, 'Rewrite Systems on a Lattice of Types', Acta Informatica, 22, pp149-169, 1985.
14. R W Witty, 'Sixth Annual Lecture of the C&CD of IEE "Software Engineering"', RAL-85-007, Dec 84.
15. C P Wadsworth, 'Report on the IOTA Programming System and other Japanese Advanced Research', RAL-84-090.