my ~~GKM file~~.
My DIC/SEGN file

SCIENCE AND ENGINEERING RESEARCH COUNCIL
RUTHERFORD APPLETON LABORATORY

INFORMATICS DIVISION

S O F T W A R E E N G I N E E R I N G G R O U P N O T E 0 1

issued by
R W Witty

SEG Annual Report
(Draft for discussion)

17 October 1984

DISTRIBUTION:
F R A Hopgood
R W Witty
D A Duce
Spares (2)

(see over page)

SOFTWARE ENGINEERING GROUP

a. Software Technology Initiative

In November 1981 the SERC launched a national, coordinated initiative to increase the amount and quality of academic software engineering research. RAL has coordianted the STI since its inception. The Programme had built up to over 40 projects by September 1984. The organisation of the STI has been very similar to the DCS Programme and so is not detailed here.

b. Advent of the Alvey Programme

The SERC's Roberts Panel Report farsightedly highlighted the national urgency for an increased level of UK Information Technology research.

When the Japanese launched their Fifth Generation Computing Systems initiative the UK government responded by setting up the Alvey Committee to consider the UK's position. The SERC was able to make a substantial contribution to the Alvey Report thanks to its Roberts Panel inspired Information Engineering activities, including the STI and the DCS Programmes. Experience had thus been gained of the management of IT research on a national scale and plans for further initiatives were already in the pipeline.

Following the establishment of the Alvey Directorate, formed from a collaboration between SERC, DTI, MOD, academe and industry, it became clear that the STI was, in reality, a subset of the proposed Alvey Software Engineering Programme. Thus the STI was transferred to the Alvey Directorate and the STI Coordinator seconded in June 1983 to act as Deputy Director of the Alvey Software Engineering Programme. The STI was therefore prematurely terminated in November 1984, in its role as an SERC programme, but lives on, in expanded form, as the academic portion of the Alvey Software Engineering Programme. The Alvey SE Director now has responsibility for all the STI initiated activities.

c. New Software Engineering Group at RAL

In August 1983 a new Software Engineering Group was formed, headed by Dr R W Witty, to

(a) help manage the Alvey Software Engineering Programme

(b) give technical support to the Alvey Directorate

(c) conduct collaborative software engineering research.

The Group also contained the DCS coordination and support activity (see below) until the closure of DCS in September 1984 and the STI Coordination until its transfer in November 1984.

The Group's research interests are in formal specification and mechanically assisted theorem proving. A research project investigating the problems of formally specifying the GKS graphics ISO standard has been approved and is under way.

d. The Distributed Computing Systems Programme

The DCS Programme has been a major influence in the way Information Technology research is organised in the UK and as RAL has played a major role in DCS a comprehensive summary of the programme is given below.

The Distributed Computing Systems Programme was a specially promoted programme launched by the Engineering Board in 1977 which terminated in September 1984.

The Programme terminated with a conference at the University of Sussex form 3-6 September, attended by some 180 delegates from academia and industry.

Two books were published in conjunction with the final conference:

1. Distributed Computing, eds F B Chambers, D A Duce and G P Jones, Academic Press, 1984. The 5 2-day tutorials given at the start of the conference were based on this volume. Areas covered are dataflow, loosely coupled systems, closely coupled systems, declarative languages and architectures, and modelling and verification of concurrent systems.

2. The Distributed Computing Systems Programme, ed D A Duce, Peter Peregrinus Limited, 1984. This volume contains the 17 papers presented at the conference itself. Review papers are included as well as papers describing the results and achievements of particular projects.

RESEARCH THEMES

As the programme evolved, projects clustered around ways in which to structure distributed systems:

1. Loosely-coupled distributed systems are multicomputer configurations that do not share immediate memory and can be dispersed over wide geographical areas.

2. Closely-coupled distributed systems. are systems which do share a common memory.

3. Non von-Neumann architecture research was concerned with alternative ways to provide high speed numerical computing and the efficient evaluation of declarative languages.

A fourth major theme was concerned with theories of parallel computation and with the development of notations and techniques for specifying and verifying such systems.

INDIVIDUAL PROJECTS

It is useful to describe a small number of projects funded by the DCS, by way of illustration. Descriptions of all the projects funded may be found in [1].

The work on loosely-coupled systems can be traced back to the work of Wilkes, Needham and others at Cambridge which led to the construction of the Cambridge Distributed Operating System [3]. A key component in this

work was the design of the Cambridge Ring local area network. From Cambridge, this approach spread to the University of Kent and other sites, including York, Keele, Oxford, Strathclyde and Newcastle; all of whom made their particular contribution to knowledge in this area. A particularly important step came early in 1980 when DCS constructed 6 Cambridge Rings. The demand for this equipment from research groups was considerably in excess of supply and the Panel, recognising the opportunity to foster the take-up of this result by industry, placed a contract with U.K. industry for the construction of further Ring hardware. This was a formative step in establishing the supply of Ring equipment in the U.K. The availability of common hardware for the pursuit of research in this area had a very beneficial effect in drawing research groups together.

The Manchester Dataflow Project demonstrated the viability of a parallel computing system based on the dataflow model of computation, which exploits irregular parallelism at the instruction level. It allows a wider range of applications than the more rigid vector and array processors. The prototype machine demonstrated performance improvements through concurrency almost lineal for up to 10 processing elements. This project delivered concrete results where previously there was only speculation. The prototype hardware is being used both by research institutions and by industry to assess the direction of future dataflow products.

In the declarative architectures field, the ALICE Project is investigating the development of applicative languages, their use in real-world problems, formally based development systems and implementations on highly parallel architectures. This project has received a great deal of public interest and has produced significant papers on language design, programming methodology and computer architecture.

Turner (Kent) contributed to the areas of declarative language design (SASL, KRC, Miranda) and evaluation (combinators). Henderson (Stirling) explored the problems of producing purely functional operating systems. Sleep (East Anglia) also explored the distributed evaluation of applicative languages.

Within the loosely-coupled systems field, the Unix United work of Randell's DCS sponsored group [4] received wide acclaim and is being exploited commercially. Distributed filestores and operating systems were investigated at Keele (Bennett), York (Wand), and Strathclyde (Shepherd). Bornat and Coulouris (QMC) investigated one approach to the construction of such systems (Pascal-m)

The main groups in the tightly-coupled systems area are those of Aspinall (UMIST), Evans (Loughborough) and Grimsdale (Sussex). Each constructed a model system and explored its applicability to a range of problems.

The work of Milner and Plotkin on theoretical models of concurrent systems received world-wide acclaim. Several U.K. companies are exploring the applications of these techniques to their application areas. Cunningham's group (Imperial College) and Hoare's group (Oxford) made

significant advances in the specification of concurrent systems.

SOME STATISTICS

The table (Fig 1.1) illustrates the scale and breadth of involvement which DCS has created and managed over the past few years. In particular, the investment which the programme has made in infrastructure and coordination, amounting to about 27% of the funds expended, has enhanced the overall value of the activity enormously.

Normal research grants awarded	103
Cooperative grants awarded	3
Visiting Fellowships awarded	20
Universities holding DCS grants	23
Polytechnics holding DCS grants	3
Number of research staff employed (approx)	150
Total value of grants awarded	6.3M
Expenditure on coordination	0.4M
Expenditure on infrastructure	2.0M
Total expenditure	8.7M
Fractional spend on infrastructure	23%
Fractional spend on coordination	4.6%

Fig 1.1

ACHIEVEMENTS

The major achievement of the DCS programme has been to create a strong research community in the U.K.

DCS established new research groups where none previously existed and enabled a number of young researchers to become established in the field much more rapidly than otherwise would have been the case. The human interface between the SERC Panel and its clients, through the coordinators, has been a key factor in bringing this about.

The establishment of the U.K.'s strong position in declarative systems research owes much to DCS.

Now that the DCS programme has ended, the work funded by DCS will continue through either the Alvey Directorate or the SERC's Computing Science Sub-committee as appropriate. Research ideas fostered by DCS are appearing in products and prototypes in the Alvey programme.

Without DCS the discussions which lead to the formation of the Alvey programme could not have taken place. Many of the lessons learned in the DCS programme have been incorporated in the Alvey programme, for example the need for full-time technically competent staff to manage the programme and the need for infrastructure both in terms of a workshop

programme and computing resources.

The DCS books [5,6], plus the research publications of the participants in the programme, mark the intellectual achievement of the programme. In terms of contribution to knowledge, the programme should claim, for example: the advance and earliest use of local networking technology through the Cambridge Ring; the development of new architectural techniques, particularly for Dataflow and Graph Reduction systems; creation of some of the first techniques for specifying and describing concurrent computation; and methods for performance modelling and analysis in complex systems.

Technology transfer to industry is much harder to estimate. The main products of the DCS programme are ideas and demonstrations of ideas, rather than systems that can, and should, be turned directly into commercial products. Trained manpower has also been a major product of the programme, and it is through this avenue that technology transfer is best being achieved. More than one company, has benefited directly from DCS manpower!

ACKNOWLEDGEMENTS

The DCS programme has involved a very large number of talented researchers, whose contributions to the programme SERC wish to acknowledge globally here. SERC also wish to acknowledge the contributions made by the former chairmen of the DCS panel, Iann Barron, Ian Pyle, Roger Needham and Roger Newey, together with all who have served on the panel; and the coordinators of the programme, Bob Hopgood, Gill Ringland, Rob Witty, Jeremy Tucker, David Duce and Fred Chambers.

REFERENCES

1. DCS Annual Report, available from Dr D. A. Duce, Computing Division, Rutherford Appleton Laboratory, Chilton, Didcot, OXON OX11 0QX

2. Distributed Computing - A Review for Industry, Proceedings available from Dr D. A. Duce, address as above.

3. R. M. Needham and A. J. Herbert, The Cambridge Distributed Computing System, Addison-Wesley, 1982

4. D. R. Brownridge, L. F. Marshall and B. Randell, The Newcastle Connection - or UNIXes of the World Unite, Software Practice and Experience, Vol. 12, No. 12, December 1982

5. Distributed Computing, eds D. A. Duce, F. B. Chambers and G. P. Jones, Academic Press, 1984 (the tutorials).

6. The Distributed Computing Systems Programme, ed. D. A. Duce, Peter Peregrinus Ltd, 1984 (the Conference).

SEG PUBLICATIONS

1. Distributed Computing Systems Programme Conference Book
   Edited by D A Duce

   published by:
   Peter Peregrinus Ltd
   Southgate House
   Stevenage
   Herts SG1 1HQ

   ISBN 0-86341-023-5

2. Distributed Computing Tutorials Book
   Edited by F B Chambers, D A Duce and G P Jones

   published by:
   Academic Press Inc (London) Ltd
   24-28 Oval Road
   London
   NW1 7DX

   ISBN 0-12-167350-2

3. Report on the IOTA Programming System and other Japanese Advanced Research

   Dr C P Wadsworth

   RAL Report number RAL-84-090

4. DCS Annual Report 1984

5. STI Final Report 1981-1984

6. Alvey Software Engineering Strategy