FACS FACTS

The Newsletter of the BCS Formal Aspects of Computing Science SIG

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Editor   Jawed Siddiqi

This copy of FACS-FACTS should be with you before the winter solstice celebrations begin. Whilst we have you in the festive and hopefully generous spirit, there is a reminder to renew your membership. You should also be receiving forms to complete from John Cook.

To provide you food for thought there are pre and post Christmas events, the two user meetings and our own meeting on domain theory are appetizing aperitifs. Those of you wanting some healthy exercise after the Christmas and New Year celebrations may want to come along to our refinement workshop.

We are grateful to Eliktronik Brane for their contribution of The ACME SCHOOL OF ENGINEERING RESEARCH final exam paper for our F.X. REID item.

Happy winter solstice.

Jawed Siddiqi

BCS - FACS

Formal Aspects of Computing Science

FACS Subscriptions for 1992

Dear FACS member

regrettably it is time to ask you for money again.

As agreed at the AGM the rates for members of BCS and sister societies has been raised to £10 whilst for others it remains at £25. The EATCS fee remains at £6 whilst the cost of the Journal is increased to £33 for volume 4. Note however that volume 4 will be published in 6 issues; representing a 50% increase in size and hence the discount is even higher than 70%+ of earlier years.

Members in the UK will be aware that the BCS is in somewhat of a financial predicament. Despite the many rumours there has been no clear statement of the position from central BCS.

Although being an integral part of BCS, the FACS group have never been a drain on BCS resources; we have been self-sufficient and through the journal we actual contribute to BCS funds. We are therefore anxious to maintain our activities and the committee are seeking ways by which we can ensure that we are not adversely affected by the financial (ill-)health of the BCS.

When we have something sorted out we shall publish details of the measures we propose to take. In the meantime you can be assured of our best endeavours to keep FACS on an even keel.

Dr D J Cooke, Chairman

Please reply to: John Cooke, Department of Computer Studies, Loughborough University of Technology, Loughborough, Leics LE11 3TU, UK. tel: +44 (0)509 222676, email: D.J.Cooke@lut.ac.uk

1

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Z

user meeting

The sixth annual Z User Meeting
Monday and Tuesday
16th and 17th December 1991

University of York

This year the Z User Meeting will be held at the
University of York - an attractive and compact campus
located two miles from the city centre and most hotels.
A lecture theatre which can accommodate 150 people,
an exhibition area and a reception area for teas and
coffees have been reserved in Vanbrugh College.
Bedrooms, lunches and a conference dinner on Monday
night have been arranged in Alcuin College (see
enclosed map).

For details and bookings telephone York (0904) 432782
Email: `sue@uk.ac.york.minster`

Z user meeting

Programme committee: Jonathan Bowen, Oxford University PRG
David Duce, Rutherford Appleton Laboratories
Tim Hoverd, Logica Cambridge
Darrell Ince, The Open University
Peter Lupton, IBM Hursley
John McDermid, University of York
Silvio Meira, University of Pernambuco, Brazil
John Nicholls, Oxford University PRG (Chair)
Gordon Rose, University of Queensland
Chris Sennett, DRA Malvern
Jim Woodcock, Oxford University PRG
John Wordsworth, IBM Hursley

The meeting will include presentations on a variety of topics of general interest to Z users, covering the theory and application of Z. Refereed papers include:

> The use of Z: report of a survey
> Extending the useful application domain for formal methods
> Application domains for formal methods
> Recursive free types in Z
> On free type definitions
> Enhancing the structure of Z specifications
> Structured analysis - A draft method for writing Z specifications
> Report on the ZOOM Workshop
> A logic for Z
> ZedB: A proof tool for Z built on B
> Z and Hoare logics
> A method for the specification of relational database applications
> Z - - an executable subset of Z

There will also be invited speakers, tool demonstrations and posters.

Monday 16th December
 Registration: *from*   *9.00 a.m.*
 Opening session   *9.30 a.m.*
 Close   *5.30 p.m.*

Dinner in Alcuin College, York   *7.00 p.m. for 7.30 p.m.*

Tuesday 17th December
 First session   *9.00 a.m.*
 Close   *4.00 p.m.*

Proceedings of the Fifth Annual Z User Meeting have been published by Springer-Verlag in their *Workshops in Computing* series (ISBN 3-540-19672-2). We also expect to publish the papers from this year's meeting — details to follow.

6

Z user meeting   *Registration form*

Please reserve a place at the Z User Meeting on 16th and 17th December 1991
as follows:

Registration fee: £130   _____

(This covers admission to all sessions, refreshments, two lunches and a special
dinner on Monday, together with preprints of papers.)

Special dietary requirements: _____

Accommodation at the University of York:
     One night bed & breakfast in an en-suite bedroom: £20
     (Monday 16 December 1991)   _____
     Two nights bed & breakfast in an en-suite bedroom: £40
     (Sunday 15 & Monday 16 December)   _____
     One night bed & breakfast with shared use of bathroom: £15
     (Monday 16th December 1991)   _____
     Two nights bed & breakfast with shared use of bathroom: £30
     (Sunday 15 & Monday 16 December 1991)   _____

There are a limited number of en-suite bedrooms on campus and they will be
allocated on a 'first come first served' basis.
                                _____

I enclose a cheque payable to the University of York for   _____

PLEASE NOTE: Remittance MUST accompany the Registration Form

Details for registration (in block capitals please):

Full name (and title): . . . .

Organisation: . . . .

Address: . . . .

                     . . . .

                     . . . .

     Postcode: . . . .

Telephone: . . . .

Fax: . . . .

Email: . . . .

Please complete a separate form for each participant and return, with your cheque, as
soon as possible *(not later than 29th November 1991)* to:

Mrs Sue Helliwell	Tel: York (0904) 432782
Department of Computer Science	Fax: York (0904) 432767
University of York	Email: SUE@UK.AC.YORK.MINSTER
YORK YO1 5DD	

BCS-FACS
Christmas Meeting 1991
on Domain Theory

The Christmas Meeting this year will provide a gentle introduction to Domain Theory for non-specialists. All of us who have written programs in which we have defined recursive procedures or functions, recursive data types or recursive processes have no doubt wondered what such definitions really mean. Probably we have an informal operational model in our minds if we try to answer such a question. Domain theory provides a mathematical (denotational) description of the meanings of programs; it allows us to solve recursive equations involving sets, functions and processes.

These days there is much emphasis on formality in order to meet the challenges of developing reliable and safety critical software. We must be able to rely on the mechanisms which translate our high-level language programs into machine code and thus it is essential that those programs have well-defined, unambiguous meanings and that provably correct translators and interpreters can be constructed.

On the first day a general introduction to the whole field will be given, and then presentations will focus on sequential languages. On the second day issues related to concurrency and non-determinism will be addressed.

This is an opportunity to hear the central ideas of the field expounded by some of the foremost researchers in the field active in Britain.

Speakers include:	Steve Schneider, PRG Oxford Steve Vickers, Samson Abramsky, Mike Smyth, Imperial College Andy Pitts, Cambridge Geoff Barrett, Inmos
Date and time:	19th, 20th December 1991 Registration at 10.00am on 19th December; meeting ends at 4.00pm on 20th December.
Place:	City University (College Building, St John Street, EC1)
Fees:	Standard Rate £65, including VAT Reduced Rate for FACS members £50, including VAT (includes lunch, and morning and afternoon refreshments)
Accommodation:	Delegates are asked to make their own arrangements.
Organisation:	David Till and Maxine Wortley, Department of Computer Science, City University, 071-253 4399 ext 3701

Reply slip, to be returned to:

Maxine Wortley
Dept of Computer Science
City University
Northampton Square
London EC1V 0HB

I would like to attend the
BCS-FACS Christmas Meeting on
Domain Theory
19, 20th December1991

I enclose a cheque made payable to **BCS-FACS**
in payment of the fee for attendance

I am a member of the BCS-FACS group £50 Reduced Rate ❑	Non-Members £65 Standard Rate ❑

I would like vegetarian meals   ❑Yes ❑No

Name: _____

Organisation: _____

Address: _____

_____

_____

_____

Signed: _____

For FACS use only:

Receipt/Invoice Number: DT91-12-19-_ _ _ _

Date Payment Received _ _ /_ _ /_ _   Amount £ _ _

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THE ACME SCHOOL OF ENGINEERING RESEARCH

FINAL EXAM PAPER 1987

You should answer as many questions as you can.

QUESTION 1

> *The purpose of ACME's strategy is to improve the agility of Britain's manufacturers by a programme of innovative investigation and research management in advanced manufacturing at higher-education institutes, integrated with a programme of enervating exercises and dietary management at lower-education institutes. The research portfolio over the last few years has fallen squarely in the early synthetic stages of research. We expect that it will soon become more rounded (*1) as it moves into the stages of dialysis and quantified comparison of performance.* [A COD Research Strategy, Neaubrene, 1987]

Discuss whether this shift of emphasis in the funding programme is a real phenomenon, or an artefact of the use of the numerically controlled machine tool metaphor as a method of discursion. You should refer to the problems of tape proving in at least two of your answers.

50 marks 30 mins

QUESTION 2

There are many stages to research. Compare and contrast the virtues of Sabin's Sharp Questions (*2) with Ludhyar's Lunation Phases (*3) for distinguishing between the stages of scientific research.

SABIN	LUDHYAR
singular	
Achievement Phase	*Crescent Phase*
1. Wouldn't it be nice if...	Introspective aborption.
2. How can we do it?	Delight in self expression.
3. Can this method do it?	Curiosity about acting on the world.
4. Try this method out.	Delight in achievement of effects.
plural	
Performance Phase	*Decresecent Phase*
5. Which of several is the best?	Curious observation of others.
6. What do the differences depend on?	Delight in manipulating others.
7. Try them all out.	What does it all mean?
8. Generalise and become an expert.	Communication of solution to others.

50 marks 30 mins

QUESTION 3

In the table of Question 2 above Sabin asserts that only stages 5-8 are suitable for academic research funding, whereas Ludhyar claims that only the gibbous phase (i.e. stages 3-6) is suitable. Semira makes the general claim that eightfold divisions are unsuited to the dialectics of activities whose main product is information, which should be analysed in terms of the ten Sephirothic nodes, with research funding from nodes 3 to 8. Moorcock and Witherspoon argue for a twelvefold genethliacal analysis in terms of the equinoctial and sidereal zodiacs, with research funding between Aquarius and Virgo. McCullough favours analysis of the research cycle in terms of the twenty-two (twenty-one) major arcana, using Crowley's rationalisation of the Florentine ordering, and bottom up research funding.

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* The footnotes are to help you with your answers. You will find them at the bottom of the next page.

10

Discuss. You may draw examples from the portfolios of the biological, biochemical, mythological, and engineering directorates.

60 marks 45 mins

QUESTION 4

What is wrong with British manufacturing industry today is that it does not know how to predict the effect of a variation in operating circumstances upon the profitability of its methods, and consequently does not know when to change from one method to another.
[The Seven Stages of Industrial Exploitation, **Neaubrene**, 1987]

A) - Discuss this in the context of the plight of UK manufacturing industry in the 1980s, illustrating with examples of industrial failure resulting from ignorance of the effects of a variation in operating circumstances. You should refer to Thatcher's Principle (*4) in your answer.

45 marks 20 mins

B) - Select one example of a variation in operating circumstances. Devise a research project and industrial exploitation route designed to discover the effects of this variation in operating circumstances and to communicate this to the ignorant industrialists. Your answer must be diplomatic and less than six centimetres in length (*5). You must not use the terms *strategy* or *basic research*.

900 marks 13 hours (*8)

QUESTION 5

*Once the appropriate distinguishing criteria have been isolated, it is possible to map the problem space showing the regions of optimum applicability of each method of solution (*6). This is the most scientific stage of research, but because it is rather boring it should ideally be done by someone else (other than the inventors of the solutions).* [The Seven Separate Stages of Scientific Search, **Neaubrene**, 1987]

A) - Suppose the research problem is devising an academic research strategy relevant to the needs of manufacturing industry. Using the above technique draw a map of the problem space with respect to the following methods of devising a strategy, taking care that the method definitions you use are constructed to the same standards. Use the coloured crayons provided.

1. Sabin's Sharp Questions.	12 marks	
2. Ludhyar's Lunation Cycle.	15 marks	
3. Semira's Sephirothic Nodes.	19 marks	
4. The Alvey Surprise.	7 marks	
5. Egginton's Method.	0 marks	
6. Any other method.	55 marks	

5 mins

B) - Explain why this stage of devising a research strategy is the most scientific. Why do you suppose - Neaubrene thinks it is boring? (*7)

40 marks 5 mins

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* The footnotes are optional. You may consult them if you wish. They may be found at the bottom of the next page. They may be found at the top of the next page. They may have been removed in order to prevent them distracting you from the exam questions. Or they might have got torn off by accident. This is a typical industrial problem (and this is an ACME exam paper).

*1 Square *or* round. The specific *shape* is not important. What Dr Neaubrene is getting at here is not so much the importance of specific *geometric* shape as the importance of specificity *about* geometric shape (*6). In other words, the lexical invariance is more important than the abductive inference - at least as far as manufacturing industry is concerned.

*2 *Sabin's Sharp Questions* were devised as a method for structuring conjecture in domains characterised by only minor discontinuities in the differentials of insignificance, with consequent difficulty in the perception of the major internal elements of semantic articulation, e.g., the WP syndrome (see page 4).

*3 *Ludhyar's Lunation Phases* derived originally from an astrological study of the behaviour of lunatics, but have been found since to apply usefully to the WP syndrome, as well as many other diverse areas of confusion. They are less pointed than *Sabin's Sharp Questions*, but are of much wider applicability, e.g., Moore's use of them to analyse the development of the policies of the two major political parties before the 1987 election [Old Moore's Almanack, **Moore**, 1986].

*4 *There is no alternative* (see Kinnock).

*5 You may, however, use tiny handwriting, lots of footnotes, or your imagination. Footnotes must be on a separate sheet for the usual reasons. This sort of thing is often requested by research funding agencies. The important questions are the scientific merit, timeliness, and industrial relevance of the case as submitted to the grant funding agency proposal submission panel reference subcommittee members (in octuplicate), and since this would otherwise naturally be presented in the form of a document whose structure reflected that of the ideas, this would tend to produce an unfair advantage in favour of that subset of the group of proposers competing for the particular tranche of funding capability in question who were good at writing documents, which of course has no necessary causal connection with the scientific merit or industrial relevance of their proposals, and so might improperly arouse the approbation of those members of the subcommittee who had actually read it, whereas, on the other hand, those who relied on squinting surreptitiously at the copy of the committee member seated beside them, while pretending that they were merely jogging their memory on points of detail, might be misled by the tendency of ponderous verbosificativitation to scare those who were frequently punished for stupidity at school (as manifested by the inability to construe complex prose passages full of monstrous words, subordinate death traps, and intricately negated semantic locks) into thinking that it might not be advisable not to deny that it was not indeed a most seriously clever proposal. I blame Cartesian Dualism. Of course one cannot make judgments of grant requests with the precision that is possible in engineering matters (at least in theory), but it is obviously silly to try to study one variable, such as merit, while others, such as length, gravity, and semantic drift, are uncontrolled.

*6 This is an example of the use of geometric modelling to express relations between features of ideas. Clearly this technique could be extended to permit anything whatsoever to be expressed within the formalism of a suitably enhanced geometric modeller. That is why geometric modelling is of such central importance in ACME's engineering research programme - because people think in terms of pictures. Our research shows that 100% of engineers answer affirmatively to the question "*do you think in terms of pictures?*". Only 66.6% of a randomly drawn control group of non-engineers answered affirmatively. The other 33.3% did not understand the question. Further questioning of this 33.3% elicited the remark that he found thinking very difficult anyway. These figures add up to nearly 100% and therefore pass the round pi test of statistical significance at the Thatcher level of confidence (*4). QED.

*7 This is a trick question.

*8 You will be pleased to know that your answer to this question was excellent, and the only reason we are giving you zero marks is that we had already allocated all the marks to the previous questions, due to a computer error. This is a purely temporary situation and will probably not affect next year's candidates.

ZED : A Z Notation Editor and Syntax Analyser

Graham. R. BUCKBERRY.

Sheffield City Polytechnic, Department of Computing and Management Science.

The Z notation for specifying and designing software has evolved steadily over the last decade, and it is now possible to identify a standard set of notations which captures the essential features of producing formal specifications in Z.

The fact that such a standard notation now exists allows for the possibility of computer assistance in writing and manipulation of Z specifications. At present, research into such computer based tools is in its infancy, with early tools providing little more than word-processing facilities. However, research is now concentrating upon building tools such as syntax checkers, structured editors, type checkers and prototyping systems, which will be vital if Z is ever to be accepted as a specification tool in an industrial environment. At present, research into a prototyping tool for Z specifications is taking place at Sheffield, using an extended LISP syntax into which the specification to be prototyped must first be manually converted. This paper describes the development of ZED ; a front-end tool for such a system, involving a PC-based graphical structured editor for entering Z specifications directly into the computer, and an in-built syntactic analyser based on the standard Z notation devised by J.M. Spivey at the Oxford University Programming Research Group.

About the ZED System

ZED is a graphical, full screen PC-based editor package and built-in syntax analyser for writing formal specifications in the Z Notation. The aim is to allow specifiers to type Z specifications directly at the computer and to have the specifications checked for correctness in the usage of the notation automatically. ZED is a partially syntax-based editor in that it

understands the format of the Z notation and provides utilities for automatically manipulating and formatting vertical schema box graphics directly on the editor screen. Many of the special mathematical notation characters are built into the editor and can be accessed through combinations of the function keys , and the ALT, SHIFT and CONTROL keys of the PC keyboard.

When invoked, the built-in syntax analyser identifies any Z Notation syntax errors in the file currently being edited and highlights their location in the file. The syntax analyser is designed to conform to the standard Z notation syntax devised by J.M Spivey, and provides appropriate error messages if errors are discovered. In this way, the specifier can check the specification for correct usage of the notation whilst in the editor and hence produce a correct specification very easily.

ZED allows specification files created to be saved to the PC hard disk or diskette, and reloaded at a later stage for further modification. ZED also contains a utility to convert specification files into IBM graphics files which can then be printed on an IBM graphics-compatible printer in order to produce hard-copy.

It is J.M. Spivey's work which forms the heart of the system developed for this project. Both the graphical editor and syntax analyser of the system are based on Spivey's symbol and syntax definition for the Z notation found in his book *"The Z Notation : A Reference Manual"*.

The Importance of Computer-Based Formal Methods Tools

Coming from an industrial software background, it is my experience that the level of computer-based tool support for a particular software methodology is the key to its success or failure within the software industry. One of the main reasons why formal methods have not yet taken off in industry, may be the current lack of available tools to support these methods and their particular way of working. In industry, we are currently seeing several tools beginning to get a hold on the market, which support specific software specification and design methodologies. Suppliers are now beginning to realise that in order for a methodology to succeed it must be adequately supported by computer based tools.

In terms of specification and Z, the reasons behind the importance of tools can be identified by examining the problems encountered with applying the formal specification techniques themselves. Communication problems arise since the specifiers generally need to use the language of mathematics, whilst the developer and the customer use terminology relating to the system being developed. Within the specification process it is vital that there is a common understanding between specifier and customer/designer if costly errors in specification are to be avoided. Regardless of whether the specification is produced in Z and is proved to be correct, if it cannot be understood by the customer, how can the customer tell if the specification is what is wanted? This requires that the customer either becomes an expert in Z, or some sort of *prototype* is produced from the specification which exhibits the characteristics of the system, whilst omitting the detailed operation.

The prototype is now seen as an important step in many new software methodologies and much research is currently underway into prototyping environments for several methodologies, including an environment for prototyping Z specifications, developed at Sheffield City polytechnic.

However, the current system requires that the Z specification to be prototyped be converted into an extended LISP syntax which can then be 'executed' by the prototyping system. At present this conversion must be done manually. Also, the prototyping system does not check the syntax or semantics of the Z specification represented by the extended LISP. This allows for the possibility that the manual conversion process may introduce errors or ambiguities which are not present in the original Z specification, and therefore weakens the use of formalism in the system. These problems are attributable to the fact that:-

a)   The prototyping system does not support direct entry of the Z notation specification into the system, and

b)   Much of the possibility for checking the formal specification is lost once it has been converted into the extended LISP syntax.

In order to be able mitigate these problems, this suggests that the specifier needs an *intelligent editor tool* with which to enter the specification directly into the computer. Clearly,

the tool must also have the capability to check the syntax and semantics of the formal specification before producing the extended LISP syntax required by the prototyping system.

In terms of Z, such an editor must allow the specifier full access to the notation (which is not normally found on general computer systems), and have sufficient intelligence and flexibility built in, in order to help the specifier to construct various kinds of *schemas*, move *schemas* around, allow natural language description to be interspersed with the formal notation, and guide the specifier when errors are made in input. The aim is to provide more than just a word processor, but a tool which understands the Z notation and can aid and guide the specifier in producing the specification directly on computer.

Moreover, with the advent of the Integrated Programming Support Environment (IPSE), many packages now provide a suite of tools each tailored to a particular part of the development methodology supported. If formal methods are to be successful, then tools must be available to support all the phases of the method. To this end, the *ideal* IPSE for formal methods might involve:-

i) A graphical, screen based, intelligent editor supporting the particular formal specification notation, ie Z. (Including a graphics plotter/printer program to produce hardcopy of specifications)

ii) A notation syntax analyser and semantic type checker. Ie, is the specification itself correct?

iii) A prototype harness which can take in the formal specification directly and reproduce the operation of the specification for the purposes of demonstration to the customer.

iv) A code generator to produce a program (as far as possible) directly from its specification, in the target language with the minimum of programmer assistance.

v) A prover tool, which aids the developer in proving that the program produced is correct with respect to the specification. This might involve a "test harness" idea in which a particular module has defined pre and post conditions extracted from the specification which

must be proven, or may involve support for a more rigourous mathematical approach, eg, proof by induction.

In order to research the feasibility of such a tool the ZED system was conceived as the first stage of an IPSE to support software systems development using the Z Formal Notation.

The ZED System Concept

The aim of the ZED concept was to implement a tool to achieve the first two stages of the formal methods IPSE proposed in the previous section, based on the Z formal Notation. That is, a graphical, screen-based intelligent editor supporting the Z notation, and an in-built syntax and simple semantic analyser for the Z notation. The aim being to provide the specifier with a tool with which to produce and manipulate formal specifications directly on the computer and to identify errors in the use of the notation.

The Z notation editor and syntax analyser were developed separately and then integrated to form the final system as follows:

The ZED Editor Philosophy

The ZED system editor is not fully syntax-based. Rather, the approach has been to develop an editor which has knowledge of the Z notation , in terms of layout and schema definitions, and which implements some parts of the Z syntax (ie, schema naming rules) but which does not syntax check the whole specification as the edit progresses.

The reason for not implementing a fully syntax based editor is that the Z notation grammar is inherently ambiguous and solving the ambiguity within the editor would complicate the editor algorithm. It was therefore decided to implement a separate high-level syntax checker function, which can be invoked at any time from the editor environment. This approach has the advantage that it can resolve the problems associated with syntax ambiguity, whilst retaining the most useful property of a syntax based editor ; that of highlighting syntax editors whilst within the editor environment itself. This obviates the need for a separate syntax check outside the editor.

ZED also implements a minimal list of high level Z language-supporting functions. These functions are different from the normal *low-level* editor functions such as line delete, goto line, search, etc, as they are state related according to the current actions being undertaken by the user. The language-supporting functions implemented provide enough flexibility to significantly aid in the production of Z notation specifications, without overwhelming the user with numerous manipulative commands, which is often a failure of many common editors. Rather, the emphasis has been to develop *macro* operations which lead the user through the necessary stages of an operation, allowing the user to make choices at appropriate points.

The language-supporting functions built into ZED are:-

i)   Open a schema graphic for either a schema box, generic definition or axiomatic definition. This function prompts for a schema name and formal parameter names where appropriate, enforces Z syntax rules on schema names, and draws the appropriate schema box graphic on the screen at the current cursor position.

ii)   Open a shorthand Schema definition prompting for a schema name and enforcing Z syntax rules for schema naming.

iii)   Change a Schema Header definition, allowing the user to either rename a schema and/or change the formal parameter definition.

iv)   Full Syntax and limited Semantic checking of the current state of the specification. This function can be called from the editor at any time to syntax check the specification. Following the syntax check the user is returned directly to the editor environment to continue editing or to correct any errors highlighted.

The ZED System Syntax Analyser

The ZED system syntax analyser is based on an extended grammar, derived from J.M. Spivey's original Z Notation grammar by using mathematical transformations in order to produce a grammar suitable for processing by a top-down recursive descent parser. The original grammar has also been extended to allow for several additions to the notation including use of text strings within predicates, schema renaming and other commonly used extensions.

The syntax analyser also includes a simple semantic analyser which implements variable scoping rules and usage rules but which does not currently include a full type checker. The mechanism used allows for schema inclusion, and automatically brings the variables of an included schema into scope of the including schema.

Opportunities for Further Work

On a purely implementation basis, since ZED has been written to be as portable as possible, the opportunity exists to implement the system on a different hardware base, possibly a workstation environment. The impetus behind this might be to make use of the windowing and enhanced graphics capabilities found on these machines, and would also provide a convenient interface into the existing LISP prototyping system at Sheffield. However, there are also opportunities to expand the system on the existing PC hardware base.

Extending the ZED Graphical Editor

ZED currently implements a minimal set of editor functions, and as the system is used, users will require more high-level functions to be made available.

The aim of the ZED editor has always been to facilitate language-based features which help the user write Z specifications in particular, rather than implement the sort of general low-level editor functions found in most text editors. Although a number of these low-level *cut and paste* functions are required, these have been kept to a minimum, and future work should concentrate mainly on editor functions that support the Z notation itself.

In particular, the possibility exists for building specific Z *schema calculus* functions into the editor. These *schema calculus* functions might include automatic schema expansion in order to observe the result of a particular schema inclusion, or the result of 'AND'ing and 'OR'ing a number of schemas together to produce a composite schema. Also automatic *schema composition* could be implemented as this is a useful Z utility allowing us to make new specifications out of old ones.

There are a number of other useful schema calculus functions which could be implemented, including *schema renaming* (ie, automatically renaming the stated variables of a schema to produce another schema) and *schema hiding* (removing stated variables from

the schema declaration in order to produce a new schema). These *constructor* functions as we shall call them, are useful since, not only do they cut down on the number of keystrokes required to produce a specification, but are also a valuable learning aid to writing Z specifications themselves.

Extending the ZED Syntax Analyser

Although the implemented syntax analyser includes a full syntax check of the Z notation grammar, it performs only a limited *semantic* check of the Z specification. The implementation of a type checker would be the next phase in the development of the syntax analyser, although it is recognised that this would be far from a trivial task. However, even if this were to be implemented, there is of course, no guarantee that a specification free from both syntactic and type errors can be implemented, and still less guarantee that it specifies what the customer actually wants. It is in this area that *prototyping* is of importance. The syntax analyser in ZED could therefore be expanded in order to produce the extended LISP syntax required by the Sheffield prototyping system directly from the specification, which could then be 'run' directly. More importantly, this method would also solve a problem with the current LISP system in that the system cannot enforce the type rules associated with the original Z specification. This problem is mitigated if the Z specification itself is first semantically checked before conversion, and the prototyping system need then only be concerned with animation, not highlighting semantic errors in the original specification.

Extending the System Concept

Although ZED is a comprehensive, independent tool, as explained in the introduction it has always been seen in a larger role as the front-end to an IPSE environment geared towards software development based upon formal methods. However, any subsequent development in this direction will probably require the system to be ported to a more powerful workstation environment. In the long term, the system could be made to produce input to a prototyping environment directly from the Z specification, with no user involvement. The user would then be able to sit at the workstation, type in the Z specification, run the syntax and

semantic checker tools and download the resulting specification directly into a prototyping environment. The user would then be able to run the prototype from the workstation environment and observe the results directly.

Although this sounds highly complex, it is believed that this sort of IPSE environment for formal methods is the only way in which formal methods will be seen as an acceptable approach to developing industrial software applications. Until such tools are available, Z will remain inaccessible to industrial users and hence a move to develop such tools must be of great importance.

Overall Conclusion

The ZED system described has been conceived, designed, implemented and tested , and has proved to be a useful and practical aid in writing formal specifications using the Z notation, directly at the computer.

It is believed that by building language-supporting functions into the ZED system, the problems associated with producing formal specification using the Z notation on a computer have been mitigated. The editor functions offered improve the productivity of the specifier by reducing the number of keystrokes required, and more importantly, help the specifier to concentrate on the specification itself, rather than the complex layout dictated by the Z notation.

The built-in syntax checker is an important component, not only for verifying the correctness of the use of the Z notation in a specification, but also in providing a *standard*. The fact that several published specifications tried out on the system contained syntax errors according to Spivey's definition, is somewhat worrying. This highlights the fact that at present, there seems to be no *accepted* standard for the Z notation and in several cases, certain parts of the notation seem to be used in different ways by different authors. It is vital that a common standard for the Z notation is established otherwise the formalism that the notation embodies will be weakened. Also, any computer-based tool implementing the notation must obviously have a standard available on which to base an implementation.

In purely practical terms, the fact that ZED allows Z specifications to be entered directly into the computer system, and stored on the machine for later retrieval or modification, makes the use of the notation far more accessible to would-be specifiers. People may well have avoided using the notation in the past simply because of the laborious problem of having to draw out all the unfamiliar mathematical characters and schema boxes on paper. Unfortunately, the specification then has to be stored on paper and is likely to get lost or damaged.

Also, like any development, the development of a specification is a creative, iterative process. If you want to modify a paper specification, the nature of the Z notation invariably means writing out the whole thing again even though you probably only wanted to change a small part. The fact that ZED enables specifications to be stored on disk and retrieved for modification is in itself, a powerful aid to the specifier.

The industrial debate for and against formal methods is set to continue for some time to come, and is unlikely to be resolved in their favour until computer-based tools are available to support them, and also to provide a common standard for notation usage.

Many software professionals now accept that formal methods have the capability to reduce system costs by removing errors in specification and thus preventing expensive errors in systems design and implementation.

The ability to prototype formal specifications also opens up opportunities to improve communication with the customer and assess the feasibility of a software project at an early stage in its development.

However, without the tools to support them, formal methods will remain an academic plaything, and we will have lost a great opportunity to improve the way in which software systems are developed.

The ZED system developed as described herein has shown that it is possible to develop a useful, practical, computer-based tool which is expressly designed to aid the specifier in producing Z notation formal specifications. It has also proved an important source of research into the problems of designing and implementing formal methods tools, and I

ZED : A Z Notation Editor and Syntax Analyser

believe it opens up opportunities for the development of integrated, computer-based tools

expressly geared towards industrial software development using formal methods.

Graham. R. Buckberry B.Eng, AMIEE is a Software Design Technologist currently working for

GEC Plessey Telecommunications Limited, and is a part-time student at Sheffield City

Polytechnic.

BCS FACS
Fifth Refinement Workshop
Theory and Practice of Formal Software Development
8-10 January 1992
London, UK

Sponsored by Lloyd's Register, Program Validation Ltd, and DTI

The workshop theme is Refinement: the systematic decomposition of formal specifications into designs which are functionally correct or implement important properties such as safety or information security.

Venue: Lloyd's Register of Shipping, 71 Fenchurch Street, London EC3

Invited Speakers:		
	Roger Jones	ICL
	Fernando Meija	GEC Alsthom, France
	Prof. Robin Milner	University of Edinburgh
	Dr José Oliveira	University of Minho
	Prof. Jeanette Wing	Carnegie-Mellon University
	Dr Jim Woodcock	University of Oxford

A draft programme is attached for your information.

Registration fees include lunches, intermission refreshments, workshop handouts, full **Proceedings** published by Springer-Verlag to be despatched after the workshop, and a social evening event.

Accommodation costs are **not included** in the registration fee, but rooms can be booked in student accommodation at reasonable cost in City University, which is a short Underground ride or a two-mile walk from the Workshop venue.

A limited number of assisted places are available at £60 for bona fide research students. To apply for this please use the registration form and do not enclose fee yet.

A £10 premium is charged for registrations not accompanied by a fee, except for those initially applying for an assisted place.

A Tools Exhibition will be held. Potential exhibitors please contact the Publicity Officer.

Organising and Technical Committee: Prof. Bernard Carré (Chairman), Prof. Cliff Jones (Technical Programme), Roger Shaw (Local Arrangements), Paul Smith (Publicity), Dr John Cooke, Tim Denvir, Jeremy Jacob.

Chairman:		**Publicity:**	
	Prof. B Carré,		Paul Smith
	Program Validation Ltd		Secure Information Systems Ltd
	26 Queen's Terrace		Sentinel House
	Southampton		Harvest Crescent
	SO1 1BQ		Ancells Park
	Tel: +44 (0) 703 330001		Fleet
	Fax: +44 (0) 703 230805		Hants GU13 8UZ
			Tel: +44 (0) 252 811818
			Fax: +44 (0) 252 811435

BCS FACS
Fifth Refinement Workshop
8-10 January 1992

Registration Form

Return to: Roger Shaw
              Lloyd's Register
              Lloyd's Register House
              29 Wellesley Road
              Croydon CR0 2AJ UK
              Tel: +44 (0) 81 681 4818
              Fax: +44 (0) 81 681
              Email: rcs@aie.lreg.co.uk

Name: ....

Address: ....

              ....

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              ....

Registration Fee: Enclosed / Please invoice / Assisted place requested*
                         (*Delete where inapplicable)

Encircle applicable figure:

	FACS members	Speakers	Others
Fee enclosed herewith:	£125	£125	£140
Please invoice:	£135	£135	£150

These prices include VAT. Cheques must be made payable to **BCS FACS**.

Special dietary requirements: ....

Tick if accommodation at City University is required: ....

If so encircle required dates: 7   8   9   January 1992

(unless otherwise specified, one single room will be reserved)

Tick if you would like a list of local hotels: ....

Any other information you think we may need: ....

Fifth Refinement Workshop

Wednesday 8 January

10.00 - 11.00	Posters, Registration, Coffee
11.00 - 11.05	*WELCOME*
11.05 - 12.00	Robin Milner
	Concurrent Processes as Objects
12.10 - 12.40	J Zwiers, J Coenen, W-P de Roever
	A Note on Compositional Refinement
12.40 - 13.10	Martin Ward
	A Recursion Removal Theorem
13.10 - 14.30	*LUNCH*
14.30 - 15.00	C T Sennet
	Demonstrating the compliance of Ada programs with Z specifications
15.00 - 16.00	Roger Jones
	(Title to be announced)
16.00 - 16.30	*TEA*
16.30 - 17.00	Colin O'Halloran
	Refinement and Confidentiality
17.00 - 17.30	Tool Demonstrations (talks about them)

Thursday 9 January

09.30 - 10.30	J N Oliveira
	Software reification using the sets calculus
10.30 - 11.00	*COFFEE*
11.00 - 11.30	Morten Elvang-Göransson
	Partial and Biased Refinements in VDM
11.40 - 12.10	Andrew Gravell
	Constructive Refinements of First Order Specifications
12.20 - 12.50	Maurice Naftalin
	A Model of the Refinement Process
13.00 - 14.30	*LUNCH*
14.30 - 15.30	Fernando Meija
	(Title to be announced)
15.30 - 16.00	T Clement
	Deductive Synthesis using μral
16.00 - 16.30	*TEA*
16.30 - 17.00	Lindsay Groves
	A Tactic driven Refinement Tool
18.30	*SOCIAL FUNCTION* and *BUFFET* in the London Transport Museum

Friday 10 January

09.30 - 10.30	Jeannette Wing
	(Title to be announced)
10.30 - 11.00	*COFFEE*
11.00 - 11.30	Xu Qiwen, He Jifeng
	A Case study in developing state based parallel programs - the Dutch National Torus
11.40 - 12.10	Ketil Stölen
	Proving Total Correctness with respect to a Fair (Shared State) Parallel Language
12.20 - 12.50	R Kuiper, A Cau
	Formalizing Dijkstra's Development Strategy with Stark's Formalism
13.00 - 14.30	*LUNCH*
14.30 - 15.30	J Woodcock
	(Title to be announced)
16.00 - 16.30	*TEA*

FORTHCOMING EVENTS

1991

Date: December 3 - 5
Title: The Fourth International Workshop on Petri Nets and Performance Models
Acronym: PNPM 91.
Location: Melbourne, Australia.
Sponsor: Telecom Australia.
Contact: Jonathan Billington, Telecom Australia Research Laboratories, PO BOX 249, Clayton, Vic., 3168, Australia. Tel. +61-3-5416416, Fax. +61-3-5442362.
Email: j.billington@trl.oz.au.

Date: December 4 - 6
Title: Software for Critical Systems
Location: Fairmount Hotel, New Orleans, La, USA.
Acronym: SIGSOFT '91.
Sponsor: SIGSOFT.
Contact: Mark Moriconi, SRI International, 333 Ravenwood Ave., Menlo Park, CA 94025; 'phone (415) 859-5924.
Email: Moriconi@csl.sri.com.

Date: December 4 - 6
Title: Int'l Conf. on Parallel and Distributed Information Systems
Location: Miami Beach, Southern Florida, USA.
Sponsor: SIGARCH, SIGMOD, IEEE, CS, Florida International Univ.
Contact: Amit Sheth, Bellcore, 1J-210, 444 Hoes La., Piscataway, NJ 08854; 'phone: (908) 699-3300; fax: (908) 699-9011.
Email: amit@ctt.bellcore.com.

Date: December 11 - 13
Title: First International Workshop on Deontic Logic in Computer Science
Location: Amsterdam, The Netherlands.
Acronym: DEON '91.
Contact: Dr. R.J. Wieringa, DEON '91, Department of Mathematics and Computer Science, Vrije Universiteit, De Boelelaan 1081A, 1081HV Amsterdam, The Netherlands.

Date: December 17 - 19
Title: Eleventh Conference on Foundations of Software Technology and Theoretical Computer Science
Location: India International Centre, New Delhi, India.
Contact: H Saran (IIT Delhi), FST&TCS 11, Dept. of Computer Science Engineering, Indian Institute of Technology, Kanpur 208 016, India; 'phone: (0512) 244518/214151, Telex: 0325-296, 0326-392.

1992

Date: January 6 - 10
Title: Formal Techniques in Real-time and Fault-tolerant Systems
Location: University of Nijmegen, The Netherlands.
Contact: Prof. Dr. Ir. Jan Vytopil, Real-time Systems Group, Department of Informatics, University of Nijmegen, Toemoolveld, 6525 ED NIJMEGEN, The Netherlands; 'phone: +31-80-65 2075, Fax: +31-80-55 34 50, Telex: 48228 wina nl.
Email: vytopil@cs.kun.nl.

Date: Januray 8 - 10
Title: The Fifth Refinement Workshop
Location: London.
Sponsor: BCS-FACS.
Contact: Chairman: Professor Bernard Carré, Program Validation Limited, 26 Queen's Terrace, Southampton SO1 1BQ; 'phone: +44 (0) 703 330001.
Or: Local Organiser: Roger Shaw, Lloyd's Register, Lloyd's Register House, 29 Wellesley Road, Croydon CR0 2AJ; 'phone: +44 (0) 81 681 4818.
Email: rcs@uk.co.lreg.ale

Date: January 19 - 22
Title: 19th ACM Symposium on Principles of Programming Languages
Acronym: POPL '92
Location: Albequerque, N. Mex., USA.
Sponsor: SIGACT, SIGPLAN.
Contact: Andrew Appel, Department of Computer Science, Princeton University, 35 Olden Street, Princeton, NJ 08544-2087; 'phone: (609) 258-4627.
Email: appel@princeton.edu.

Date: January 27 - 31
Title: The Second International Symposium on Environments and Tools for Ada
Acronym: SETA2
Location: Washington DC, USA.
Co-Sponsor: ACM SIGAda, IEEE Computer Society TC on Computer Languages, Cooperation being sought with ACM SIGSOFT.
Contact: SETA2, c/o Prof. Gail E. Kaiser, Columbia University/Department of Comp. Sci., 500 West 120th Street, New York, NY 10027, USA.
Email: seta@cs.columbia.edu

Date: January 29 - 31
Title: 2nd International ACM/IEEE Symposium on Environments and Tools for Ada
Location: Herndon, Va., USA.
Sponsor: SIGAda, SIGSOFT, IEEE TC CL.
Contact: Tricia Orbernborg, NADC Code 7031, Warminster, PA 18974-5000, USA; 'phone: (215) 441-2737.
Email: tricia@nadc.navy.mil.

Date: February 5 - 7
Title: Harnessing the Object Revolution: Workshop on Object-oriented Software Engineering Practice
Location: Denver, USA.
Contact: Dr. Pankaj Goyal, US WEST Advanced Technologies Inc., 4001 Discovery Drive, Boulder, CO 80303, USA; 'phone: (303) 541 6286, Fax: (303) 541 6300.
Email: pankaj@uswest.com, or: oows@uswest.com.

Date: February 13 - 15
Title: 9th Symposium on Theoretical Aspects of Computer Science
Location: Paris, France.
Acronym: STACS 92.
Sponsor: AFCET.
Co-Sponsor: GI
Contact: Prof. Alain Finkel, ENS Cachan - STACS 92, 61, avenue du Président Wilson, 94235 Cachan Cédex - France; 'phone: 33 1 47 40 22 74; fax: 33 1 47 40 20 74.
Email: finkel@enscachan.ens-cachan.fr

Date: March 10 - 11
Title: Fourth Int'l Conf. on Strategic Software Systems
Location: Huntsville, Ala., USA.
Cosponsors: IEEE Computer Soc. Huntsville Chapter, Univ. of Alabama in Huntsville.
Contact: Ann H. Yelle, Univ. of Alabama in Huntsville, Continuing Education Division, Conferences (SSS-92), Bevill Center 289-A, Huntsville, AL 35899, 'phone (800) 448-4035 or (205) 895-6372, fax (205) 895-6760.

Date: March 12 - 14
Title: DIMACS Workshop on Computational Support for Discrete Mathematics
Contact: Nathaniel Dean, Bell Communications Research, Morristown, NJ 07960, tel: (201) 829-5211.
Email: nate@bellcore.com
Or: Gregory E. Shannon, Indiana University, Bloomington, IN 47405, tel: (812) 855 7071.
Email: shannon@cs.indiana.edu

Date: March 22 - 25
Title: Fourth Conference on Theoretical Aspects of Reasoning about Knowledge
Acronym: TARK IV.
Sponsor: IBM.
Location: Asilomar Conference Center, Pacific Grove, California, USA.
Contact: Yoram Moses, Dept. of Applied Math Computer Science, Weizmann Institute, Rehovot, 76100, Israel, tel: +972-8-343435, fax: +972-8-344122.
Email: yoram@wisdom.weizmann.ac.II
Or: Mark R. Tuttle, Digital Equipment Corporation and One Kendall Sq., Bldg. 700 Cambridge, MA 02139, USA, tel: (617) 621-6635, fax: (617) 621-6650.
Email: tuttle@crl.dec.com

Date: March 24 - 26
Title: 8th British Colloquim for Theoretical Computer Science
Acronym: BCTCS 8.
Location: University of Newcastle upon Tyne, England.
Contact: Iain A. Stewart, Computing Laboratory, Univ. Newcastle upon Tyne, Claremont Road, Newcastle upon Tyne NE1 7RU, England.
Email: Iain.Stewart@uk.ac.newcastle

Date: March 29 - April 2
Title: Software Engineering Tools and Techniques Workshop
Location: New Orleans, LA, USA.
Contact: Steven Zilora, Creative Software Solutions, Inc., P.O. Box 192, Flanders, NJ 07836; 'phone: (201) 927- 8233; fax: (201) 927-7527.
Paper Submission Details:
Submit two copies of an abstract to Steven Zilora.

Date: March 30 - April 1
Title: Eighth Int'l Conf. on Software Eng. for Telecommunication Systems and Services
Location: Florence, Italy.
Acronym: SETSS 92.
Sponsor: Institution of Electrical Engineers.
Contact: IEE Conf. Services, Savoy Place, London WC2R 0BL, UK; 'phone: (071) 240-1871; fax: (071) 240-7735.

Date: April 6 - 8
Title: Programming Environments for Parallel Computing
Location: Edinburgh, Scotland.
Sponsor: IFIP WG10.3, GI/ITG-Paris, BCS PPSIG.
Contact: Rosemary Candlin, Dept. of Comp. Sci., Univ. of Edinburgh, UK EH9 3JZ; Tel: +44 31 650 5137/5128; Fax: +44 31 667 7209.
Email: rc@cs.ed.ac.uk

Date: April 6 - 10
Title: Latin American Theoretical INformatics
Location: São Paulo, Brazil.
Acronym: latin '92.
Contact: Imre Simon, Program Committee Chair, latin '92 - Latin American Theoretical Informatics, Instituto de Matemática e Estatística, Universidade de São Paulo, Caixa Postal 20570, 01498 São Paulo, SP, Brasil; Fax: (55) (11) 815-4272.
Email: isimon@brusp.bitnet.
Or: Paulo Feofiloff, Organizing Committee Chair, latin '92 - Latin American Theoretical Informatics, Instituto de Matemática e Estatística, Universidade de São Paulo, Caixa Postal 20570, 01498 São Paulo, SP, Brasil; Fax: (55) (11) 815-4272.
Email: pfeofilo@brusp.bitnet.

Date: April 20 - 23
Title: Computer Languages
Location: San Francisco, California, USA
Sponsor: IEEE Computer Society
Co-Sponsors: ACM SIGPLAN & IFIP Working Group 2.4
Contact: James R. Cordy, Dept. of Computing and Information Science, Queen's University, Kingston, Canada K7L 3N6; 'phone: (613) 545-6054.
Email: cordy@qucis.queensu.ca
Or: Mario R. Barbacci, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA 15213, USA; 'phone: (412) 268-7704.
Email: barbacci@sei.cmu.edu.

Date: May 4 - 6
Title: 24th Annual ACM Symposium on Theory of Computing 1992
Acronym: STOC '92.
Location: Victoria, British Columbia, Canada.
Sponsor: SIGACT.
Contact: Mike Fellows, Comp. Sci. Dept., Univ. of Victoria, Victoria, British Columbia, Canada V8W 2Y2; 'phone: (604) 721-7299.
Email: mfellows@crs.uvic.ca.

Date: May 4 - 6
Title: 1992 IEEE Symposium on Research in Security and Privacy
Location: Oakland, California, USA.
Sponsors: IEEE Computer Society Technical Committee on Security and Privacy, The International Association for Cryptologic Research (IACR).
Contact: John McLean, Program Co-Chair, Naval Research Laboratory, Code 5543, Washington, DC 20375, tel: (202) 767-3852.
Email: mclean@itd.nrl.navy.mil

Date: May 4 - 8
Title: IEEE Int'l Conf. on Computer Systems and Software Eng.
Acronym: Comp Euro 92.
Location: The Hague, The Netherlands.
Cosponsors: IEEE Region 8, IEEE Benelux Section.
Contact: Patrick Dewilde, Delft Univ. of Tech., EE Dept., POB 5031, 2600 GA Delft, The Netherlands, phone 31 (15) 785 089, fax 31 (15) 623 271.
Or: G. Arink, Philips Medical Systems, PO Box 10000, 5680 DA Best, The Netherlands, phone 31 (40) 762 060, fax 31 (40) 762 952.

Date: May 11 - 15
Title: 14th International Conference on Software Engineering
Acronym: ICSE 92.
Location: Melbourne, Australia.
Sponsors: SIGSOFT, IEEE-TCSE, IEA, ACS and IREE.
Contact: Lori A. Clarke, Dept. of Comp. Sci., Univ. of Mass@Amherst, Amherst, MA 01003; (413) 545-1328; fax: (413) 545-1249.
Email: clarke@cs.umass.edu

Date: May 12 - 15
Title: 4th Conference on Advanced Information Systems Engineering
Acronym: CAISE 92.
Location: Manchester, UK.
Contact: Janet Househmand, Information Systems Group, Dept. of Comp., UMIST, PO Box 88, Manchester, M60 1QD, UK.
Email: caise92auk.ac.umist.co.isg

Date: May 27 - 29
Title: Assessment of Quality Software Development Tools
Location: New Orleans, Louisiana, USA.
Sponsor: Tulane University.
In Coop.: IEEE Computer Society TCSE.
With Assist.: IBM Systems & Software Education
Contact: Ez Nahourali, IBM (798/089), 6321 San Ignacio Avenue, San Jose, CA 95119, USA; Tel: (408) 281-5741.
Email: eznah@stlvm7.iinus1.ibm.com

Date: May 28 - 31
Title: Fourth International Workshop on Nonmonotonic Reasoning
Location: Hawk Inn & Mountain Resort, Plymouth, Vermont, USA.
Sponsor: AAAI and AT&T Bell Laboratories.
Contact: Henry Kautz, AT&T Bell Laboratories, Room 2C-407, PO BOX 636, Murray Hill, NJ, 07974-0636, USA, tel: (908) 582-2815, Fax: (908) 582-7550.
Email: kautz@research.att.com

Date: June 1 - 5
Title: International Conference on Measurement and Modelling of Computer Systems
Acronym: SIGMETRICS '92/PERFORMANCE '92
Location: Newport, R.I., USA.
Sponsor: SIGMETRICS IFIP WG 7.3.
Contact: Linda Wright, Digital Equipment Corp., TAY1-2/J11, 151 Talor St., Littleton, MA 01460; phone (508) 952-4476.
Email: wright@tps.enet.dec.com.

Date: June 10 - 12
Title: 3rd Workshop on Metaprogramming in Logic
Acronym: META-92
Location: Uppsala, Sweden.
Sponsor: Assoc. for Logic Programming and Uppsala Univ.
Contact: Jonas Barklund, Comp. Sci. Dept., Box 520, S-75120 Uppsala, Sweden; +46 18 181050; fax: +46 18 521270.
Email: jonas@csd.uu.se

Date: June 15 - 18
Title: 11th International Conference on Automated Deduction
Acronym: CADE 11.
Location: Saratoga Springs, NY, USA.
Contact: Program Chair: Deepak Kapur, (518) 442-4281.
Email: cade-11@cs.albany.edu
Or: Local Arrangements Chair: Neil V. Murray, (518) 442-3393.
Email: cade-11@cs.albany.edu

Date: June 15 - 18
Title: Parallel Architectures and Languages Europe
Acronym: PARLE '92.
Location: Paris, France.
Contact: Prof. Daniel Etiemble, Universite Paris Sud Orsay, LRI, Bat. 490, 91405 Orsay Cedex, France, tel: +33 1 69 41 66 21, fax: +33 1 69 41 65 86.
Email: de@lri.lri.fr
Or: Veronique Segaut, AFCET, 156 Bd. Pereire, 75017, Paris, tel: +33 1 47 66 24 19, telex: +33 1 42 67 93 12.

Date: June 17 - 19
Title: Conference on Programming Language Design and Implementation
Acronym: ACM SIGPLAN'92
Location: San Francisco, California, USA.
Sponsor: ACM SIGPLAN.
Contact: Conference Chair: Stuart I. Feldman, Bellcore, 445 South Street, Morristown, NJ 07960-1910, 'phone (201) 829-4305.
Email: sif@bellcore.com
Program Chair: Christopher W. Fraser, AT&T Bell Laboratories, Room 2C-464, 600 Mountain Avenue, Murray Hill, NJ 07974-0636, 'phone (908) 582-3583.
Email: cwf@research.att.com
Local Arrangements Chair: Stan Osborne, Computer Science Department, San Francisco State University, 1600 Holloway Avenue, San Francisco, CA 94132, 'phone (415) 338-2168.
Email: stan@cs.sfsu.edu

Date: June 17 - 19
Title: 4th International Conference on Software Engineering and Knowledge Engineering
Location: Capri, Italy.
Sponsor: Univ. of Salerno, Univ. of Naples, CRIAI, Univ. of Pittsburgh, SWIFT.
Contact: S.K. Chang, Dept. of Comp. Sci., Univ. of Pittsburgh, Pittsburgh, PA 15260; (412) 624-8432.
Email: chang@cs.pitt.edu

Date: June 19 - 20
Title: Workshop on Partial Evaluation and Semantics-Based Program Manipulation
Sponsor: ACM SIGPLAN
Location: San Francisco, CA, USA.
Contact: General and program chair: Charles Consel, Department of Computer Science, Yale University, 51 Prospect Street, New Haven, CT 06520, USA.
Email: consel@cs.yale.edu
Local Arrangements: Stan Osborne.
Email: stan@ana.com

Date: June 20 - 21
Title: Workshop on ML and Its Applications
Sponsor: ACM SIGPLAN
Location: San Francisco, CA, USA.
Contact: Program Chair: Peter Lee, School of Computer Science, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213-3890, 'phone (412) 268-3049.
Email: Peter.Lee@cs.cmu.edu
General Chair: David MacQueen, AT&T Bell Laboratories, Room 2C-322, 600 Mountain Avenue, Murray Hill, NJ 07974.
Email: macqueen@research.att.com

Date: June 21
Title: Workshop on Continuations
Sponsor: ACM SIGPLAN
Location: San Francisco, CA, USA.
Paper Submission Details:
Olivier Danvy, Department of Computing and Information Sciences, Kansas State University, Manhattan, KS 66502, USA.
General and program chair: Olivier Danvy.
Email: danvy@cis.ksu.edu,
Or: Carolyn L. Talcott.
Email: clt@sail.stanford.edu

Date: June 22 - 24
Title: 1992 ACM Conference on Lisp and Functional Programming
Location: San Francisco, CA, USA.
Contact: General Chair: Jon L. White, Lucid, Inc., 707 Laurel Street, Menlo Park, CA 94025, tel: 415-329-8400, x5514.
Email: jonl@lucid.com
Program Chair: William Clinger, Attn: LFP 92, Computer Science Dept., University of Oregon, Euhene, OR 97403, tel: 503-346-4411.
Email: will@cs.uoregon.edu

Date: June 22 - 25
Title: 7th Annual IEEE Conference on Structure in Complexity Theory
Location: Boston, Mass., USA.
Sponsor: IEEE.
Contact: T. Long, Dept. of Comp. Sci., New Mexico Univ., Box 3001, Dept. 3CU, Las Cruces, NM 88003-0001.
Email: long@nmsu.edu.

Date: June 22 - 25
Title: 7th Annual IEEE Symposium on Logic in Computer Science
Location: Santa Cruz, California, USA.
Acronym: LICS.
Contact: Program Chair: Prof. Andre Scedrov, Inst. for Research in Cognitice Sci., University of Pennsylvania, 3401 Walnut Street, Suite 400C, Philadelphia, PA 19104-6228, USA, Fax (215) 573 2048 (Attn: LICS).
Email: lics92@cis.upenn.edu

Date: June 24 - 26
Title: Thirteenth International Conference on Application and Theory of Petri Nets and Petri Nets Tutorial 22 - 23 June
Location: Sheffield, England.
Contact: Kurt Jensen, Computer Science Department, Aarhus University, Ny Munkegade, Bldg. 540, DK-8000 Aarhus C, Denmark, tel: +45 86 12 71 88, fax: +45 86 13 57 25, telex: 64767 aausci dk.
Email: kjenson@daimi.aau.dk
Or: Conference Services, Sheffield City Polytechnic, 36 Collegiate Crescent, Sheffield S10 2BP, England, tel: +44 742 532 576, fax: +44 742 532 579.

Date: June 29 - July 1
Title: Fourth Workshop on Computer-Aided Verification
Location: Montreal, Quebec, Canada.
Contact: G. v. Bochmann, Universite de Montreal, Department d'IRO, C.P. 6128, succ. A, Montreal, Quebec H3C 3J7, Canada.
Email: bochmann@iro.umontreal.ca

Date: June 29 - July 3
Title: Sixth European Conference on Object-Oriented Programming
Location: Aarhus, Denmark.
Acronym: ECOOP '92.
Contact: Ole Lehmann Madsen, Comp. Sci Dept., Aarhus Univ., Ny Munkegade, DK-8000 Aarhus C, Denmark; Tel: +45 86 12 71 88; Fax: +45 86 13 57 25.
Email: olmadsen@daimi.aau.dk

Date: June 29 - July 3
Title: 2nd International Conference on The Mathematics of Program Construction
Location: Oxford, UK.
Contact: Carroll Morgan & Jim Woodcock, Programming Research Group, 11 Keble Road, Oxford OX1 3QD, UK, tel: +44 865 273840.
Email: carroll@prg.ox.ac.uk
Or: jimw@prg.ox.ac.uk

Date: July 6 - 7
Title: Workshop on Fault-Tolerant Parallel and Distributed Systems
Location: Amherst, Mass., USA.
Contact: N.K. Jha, Dept. of Electrical Engineering, Princeton Univ., Princeton, NJ 08544; Tel: (609) 258-4754.
Email: jha@ee.princeton.edu

Date: July 7 - 10
Title: Fifth Int'l Workshop on Computer-Aided Software Eng.
Acronym: CASE 92
Location: Montreal.
Contact: Nazim Madhavji, School of Computer Science, McGill Univ., fax (514) 398 3993.
Email: case@softeng.cs.mcgill.ca.
Or: John Jenkins, City Univ. of London, Business Systems Analysis Dept., London, UK, fax 44 (71) 608 1270.

Date: July 8 - 10
Title: International Symposium on Fault-Tolerant Computing
Acronym: FTCS 22
Location: The Lafayette Hotel, Boston, MA, USA.
Sponsor: IEEE Computer Society, University of Massachusetts.
Contact: Prof. Dhiraj K. Pradhan, Conference Chairman, Electrical and Computer Engineering Dept., University of Massachusetts, Amherst, MA 01003; Tel: (413) 545-0160, Fax: (413) 545-4611.
Email: pradhan@ecs.umass.edu

Date: July 8 - 10
Title: Third Scandinavian Workshop on Algorithm Theory
Acronym: SWAT'92
Location: University of Helsinki, Finland.
Contact: Prof. Esko Ukkonen, Department of Computer Science, University of Helsinki, Teollisuuskatu 23, SF-00510 Helsinki, Finland, tel: +358-0-7084172, fax: +358-0-7084441.
Email: swat@cs.helsinki.fi

Date: July 12 - 17
Title: 19th International Colloquium on Automata, Languages, and Programming
Acronym: ICALP 92
Location: Technische Universität Wien, Austria.
Contact: Prof. Werner Kuich, Institut für Algebra und Diskrete Mathematik, Technische Universität Wien, Wiedner Haupstraße 8-10, A-1040 Wien, Tel.: +43 1 58801 5450.
Email: kuich@btx.UUCP.

Date: July 20 - 24
Title: Symposium on Logical Foundations of Computer Science
Acronym: LFCS '92.
Location: Tver University, Tver, USSR.
Contact: Dr. I.Kh. Musikaev, LFCS '92, Tver University, 33 Zhelyabova Str., Tver 170013, USSR.
Or: Prof. V.W. Marek, Dept. of Computer Science, University of Kentucky, Lexington, KY 40506 USA, fax: (606) 257 4078, tel: (606) 257 3496.
Email: marek@ms.uky.edu
Or: Conference Manager: A.P. Stolboushkin, USSR Acad. Sci., Program Systems Inst., Pereslavi-Zalessky 152140, USSR, telex: 412531 BOAT SU.
Email: aps1@node.ias.msk.su

Date: July 27 - 29
Title: International Symposium on Symbolic Algebraic Computation
Acronym: ISSAC.
Location: Berkeley, California, USA.
Sponsor: SIGSAM.
Contact: Erich Kaltofen, Rensselaer Polytech. Inst., Dept. of Comp. Sci., Troy, NY 12180; (518) 276-6907.
Email: kaltofen@cs.rpi.edu

Date: September 2 - 4
Title: Third International Conference on Algebraic and Logic Programming
Location: Pisa, Italy.
Contact: Hélène Kirchner, CRIN & INRIA-Lorraine, BP 239, Campus Scientifique, 54506, Vandoeuvre-lès Nancy Cedex, France.
Email: hkircher@loria.crin.fr
Or: Giorgio Levi, Dipartimento di Informatica, Università di Pisa, Corso Italia 40, 56125 Pisa, Italy.
Email: levi@dipisa.di.unipi.it

Date: September 7 - 11
Title: 12th World Computer Congress, IFIP Congress 92: "From Research to Practice"
Location: Madrid, Spain.
Sponsor: International Federation for Information Processing (ISIP).
Local Organiser:
  Grupo Geyseco, IFIP'92, Mauricio Legendre 4, 8th Floor G, E-28046, Madrid, Spain. Fax: (+34-1) 3234936.
Email: ifip92@dit.upm.es.
Paper Submission Details:
  Submit six copies of a paper not exceeding 4500 words by January 10, 1992 or three copies of a one page abstract for a poster presentation by April 15 to one of the following subcommittee chairs:

  Software Development and Maintenance: A.N. Habermann, School of Computer Science, Carnegie-Mellon Univ., Pittsburgh, Pa. 15213-3890, USA, fax: (+1-412) 681-5793, e-mail: anh@cs.cmu.edu

  Algorithms and Efficient Data Structures: J. van Leeuwen, Dept. of Computer Science, Univ. of Utrecht, PO Box 80089, Padualaan 14, NL-3584 CH Utrecht, The Netherlands, fax: (+31-30) 513791, e-mail: jan@cs.ruu.nl

  From Architectures to Chips: G.L. Reijns, Delft Univ. of Technology, Mekelweg 4, NL-2628 CD Delft, The Netherlands, fax: (+31-15) 784898, e-mail: gjduve@et.tudelft.nl

  Informatics and Education: P. Bollerslev, Center for Applied Informatics in Teacher Education, Ministry of Education, Frederiksholms Kanal 26, DK-1220 Copenhagen K, Denmark, fax: (+45-33) 925302

  The Vulnerability of the Information Society: Social, Legal, and Security Aspects: K. Brunnstein, Dept. of Computer Science, Univ. of Hamburg, Vogt-Koelln-Str.30, W-2000 Hamburg 54, Germany, fax: (+49-40) 4123-6122, e-mail: brunnstein@rz.informatik.uni-hamburg.dbp.de

  Expanding the Power of the Personal Computer: F. Vogt, Univ. of Hamburg, Bodenstedtstr. 16, W-2000 Hamburg 50, Germany, fax: (+49-40) 4123-6530, e-mail: vogt@rz.informatik.uni-hamburg.dbp.de

  Enhancing the Intelligence in Information Systems: G. Davis, Univ. of Minnesota, Dept. of Information and Decision Sciences, 271 19th Ave South, Minneapolis, Minnesota 55455, USA, fax: (+1-612) 626-1316, e-mail: gdavis@umnsom.bitnet

Date: September 14 - 16
Title: 3rd IFIP Working Conference on Dependable Computing for Critical Applications
Acronym: DCCA-3.
Location: Mondello (Palermo), Sicily, Italy.
Sponsor: IFIP Working Group 10.4.
Contact: Luca Simoncini, Dipartimento Di Ingegneria dell'Informazione, Univ. of Pisa, Diotisalvi 2, 56100 Pisa, Italy; +(39) 50 593443 or 550100; fax: +(39) 554342.
Email: simon@icnucevm.cnuce.cnr.it.

Date: September 23 - 25
Title: 5th International Conference on Putting Into Practice Methods and Tools for Information System Design
Location: Nantes, France.
Contact: Henri Habrias, Liana, IUT, 3 rue MI Joffre 44041 Nantes Cedex 01 (France); 'phone: (33) 40 30 50 56; fax: (33) 40 30 60 01.
Email: habrias@naiut.dnet@ciripa.circe.fr.
Paper Submission Details:
  Submit five copies of their papers (15 pages maximum, double-spaced, (English or French) to Henri Habrias.

Date: October 7 - 9
Title: Third International Symposium on Software Reliability Engineering
Acronym: ISSRE-92.
Location: North Carolina, USA.
Contact: Mladen A. Vouk, Computer Science Department, Box 8206, North Carolina State University, Raleigh, NC 27695-8206, Tel: (919)-515-7886, Fax: (919)-515-5839.
Email: vouk@adm.csc.ncsu.edu

Date: November 9 - 13
Title: 1992 Joint International Conference and Symposium on Logic Programming
Location: Ramada Renaissance Hotel, Washington, D.C., USA.
Sponsor: The Association for Logic Programming.
Contact: Prof. Krzysztof R. Apt, Program Chair, CWI, Kruislaan 413, 1098 SJ Amsterdam, The Netherlands, fax: (+31-20) 592-4199.
Email: apt@cwi.nl

1993

Date: April 13 - 17
Title: TAPSOFT 93 (CAAP FASE Advanced Seminar)
Acronym: TAPSOFT 93
Location: Orsay, France.
Contact: Program Chair of FASE: Marie-Claude Gaudel, Program Chair of CAAP: Jean-Pierre Jouannaud, TAPSOFT 93, LRI Batiment 490, Université Paris XI, 91405 Orsay Cedex, France.
Email: tapsoft@lri.lri.fr or jouannaud@margaux.inria.fr

10

9