The CACE Project -- Steering Committee Meeting 4, 1986-11-27

Mattsson, Sven Erik; Åström, Karl Johan

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The CACE Project - Steering Committee Meeting 4

Sven Erik Mattsson
Karl Johan Åström

Department of Automatic Control
Lund Institute of Technology
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Department of Automatic Control
Lund Institute of Technology
P.O. Box 118
S-221 00 Lund Sweden

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Author(s)
Sven Erik Mattsson
Karl Johan Åström

Supervisor

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Abstract

This report contains documentation handed out to the participants of the 4th steering committee meeting of the STU Computer Aided Control Engineering Programme (CACE) on November 27, 1986. The minutes of the meeting are also included.

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PREFACE

This report contains documentation handed out to the participants of the 4th steering committee meeting of the STU Computer Aided Control Engineering Programme (CACE) on November 27, 1986. The minutes of the meeting are also included.

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THE CACE PROJECT

Steering Committee Meeting 4

November 27, 1986

9.00 INTRODUCTION

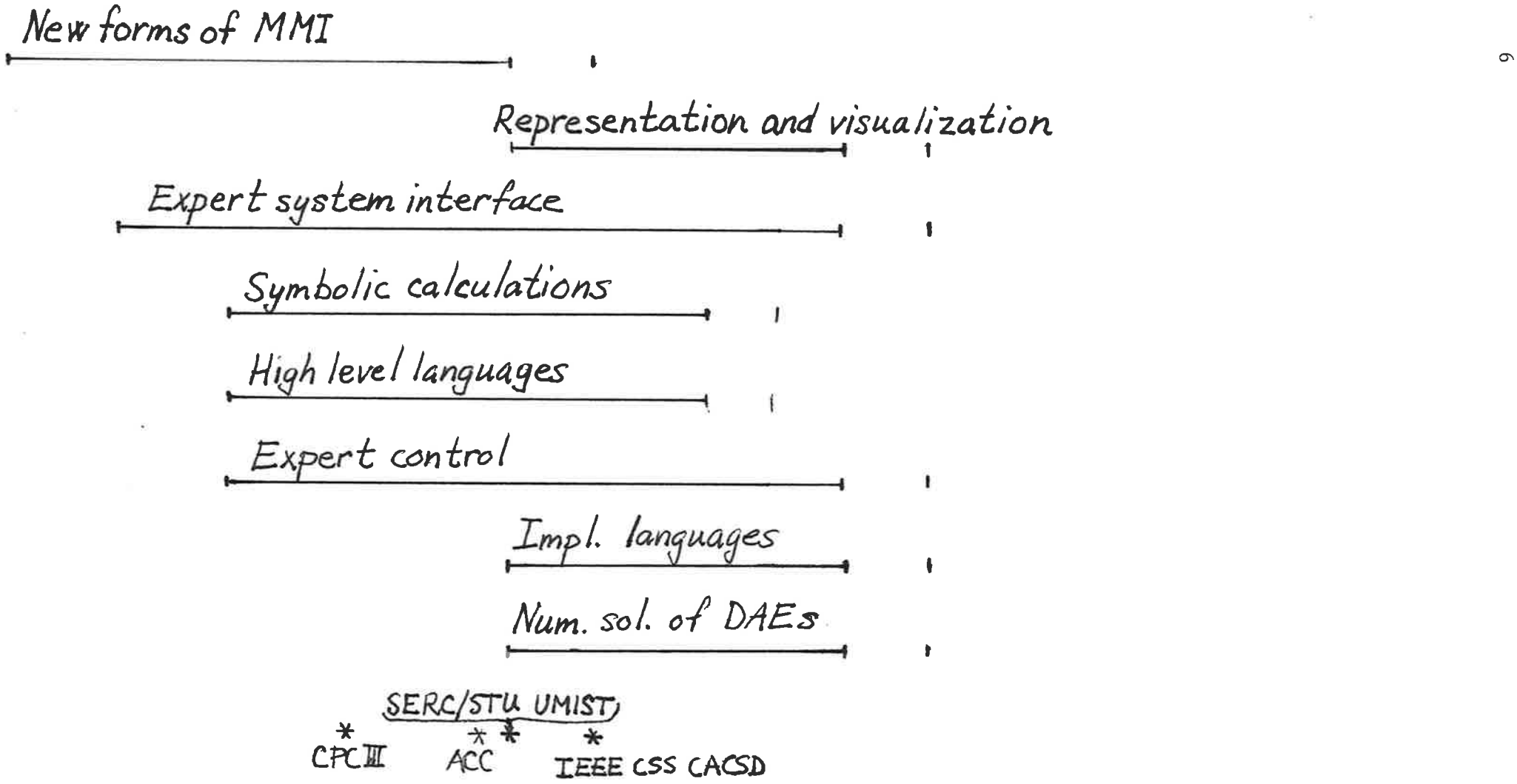
9.15 OVERVIEW OF THE PROJECT STATUS

10.15 REVIEW OF TWO PROJECTS
Knowledge based man-machine interfaces
Numerical solution of DAE systems

11.30 LUNCH

13.00 DISCUSSION ON FUTURE WORK

15.00 DEMONSTRATIONS


New forms of MMI
Representation and visualization
Expert system interface
Symbolic calculations
High level languages
Expert control
Impl. languages
Num. sol. of DAEs
SERC/STU UMIST
CPC III
ACC
IEEE CSS CACSD
1985
1986
1987

NEW FORMS OF MAN-MACHINE INTERACTION

Final report: September 30, 1986.

A prototype simulator, Hibliz has been implemented according to the project plans.

Focused on the user interface:
- Workstations with fast graphics
- Hierarchical block diagrams are useful
- Equation based modelling

Differential/algebraic systems:
- Symbolic manipulation - Numerics
- Open questions
- Linda Petzold
- Gustaf Söderlind, Bo Kågström

Graphics:
- Useful experiences for future work
- Graphics standards is an important issue
- Text important and difficult
- Windowing

Implementation languages:

We need a flexible and interactive environment
Pascal is too cumbersome for prototyping

For presentation:

1. Hibliz itself
2. Poster with color photos
3. Color slides
4. Video (7 min)

Conferences:

1. STU/SERC Workshop, UMIST, Manchester, July 14–18, 1986
2. IEEE CSS 3rd Symposium on CACSD, Arlington, Virginia, September 24–26, 1986
3. Demonstrated in connection with the 2nd IFAC Workshop on Adaptive Systems in Control and Signal Processing, 1-3 July, 1986, Lund, Sweden

REPRESENTATION AND VISUALIZATION OF SYSTEMS AND THEIR BEHAVIOUR

Purpose:

Investigate how the man-machine interface should represent and visualize systems and their properties. Particularly focus on how graphics could be used.

The first step is to set up a flexible and interactive environment which allows fast prototyping.

Upgradings of the IRIS workstation:

Increased CPU memory from 2.5 MB to 6.5 MB
80 MB Winchester disk
New window manager
Common Lisp from Franz Inc.
Steering ball with 6 degrees of freedom (ordered)

Current activities:

Designing and implementing basic graphics facilities for drawing of hierarchical block diagrams

Studying existing graphics-based user interfaces

Animation of an ASEA robot in solid 3-D graphics

Developing a specification for system modelling concepts and associated operations

COMBINATION OF FORMULA MANIPULATION AND NUMERICS

Will be finished according to the plan.

Interesting and important for the continuation:

- DAE systems
- Symbolic manipulation can give insight
- Design

Possible international collaboration:

- University of Maryland
- INRIA

Difficulties:

- Macsyma good, but too large, not modularized
- Very computer demanding
- Lisp machine
- Alternatives?
- Possibilities to incorporate in larger systems

HIGH LEVEL PROBLEM SOLVING LANGUAGES

Focused on system representations.

Other aspects have been investigated in collaboration with Neil Munro, UMIST.

The project will be finished according to the plan.

Key issues for the continuation:

MMI

System representation

Some aspects are treated in the project "Representation and visualization of systems and their behaviour."

IMPLEMENTATION LANGUAGES

Most likely several languages

Fortran

- A lot of good libraries available
- Experiences from earlier work; Simnon, Idpac etc.

Pascal

- Not suitable for large systems; Preprocessor
- Experiences: LICS, Hibliz

Ada

- Experiences: Mekanförbundet, Rimvall, SCT

Lisp

- Expert system interfaces
- Expert control
- System representations

Smalltalk

- Kreutzer

Prolog

- Contacts with SICS and ZYX

Sophisticated programming environments

- Reasoning System, HP

EXPERT CONTROL

Expert control shell has been developed.

Contains:

- Forward and backward chaining
- Planning
- Real-time primitives
- Explanation facilities.

Current activities:

- Experiments with smart controllers
- Extensions to the shell
- Documentation

Conferences:

1. Applications of AI in Engineering Practice, Southampton UK, April -86.
2. SAIS '86, The Swedish AI Society's Annual Workshop, Linköping, April 24-25, 1986.
3. ACC '86, American Control Conference, Seattle, June 18 - 20, 1986.

WORKSTATIONS

Lisp Machine

- FRN funding
- UUH
- Evaluation in progress

Workstations:

- Coordination with the department's purchasing
- New machines will be presented next spring

Demand:

- Six persons working full time
- 5-8 persons working part time

INTERNATIONAL CONTACTS

ENGLAND – SERC

Joint workshop at UMIST on graphical front ends.

Informal contacts with Neil Munro.

Visit by Mike Denham.

Joint workshop on expert system next spring.

Mike Denham, NATO Workshop

CEGB, Whitmarsh-Everiss (Large systems)

FRANCE

INRIA, Delebecque (Blaise)

INRIA, Gomez (AI, Symbolic calculations)

SWITZERLAND

ETH, Rimvall (Impact)

USA

Univ. of Maryland (AI, Symb. calc., DELIGHT)

LLNL (β-test for EAGLES)

Berkeley, Polak (DELIGHT)

Univ. of Tennessee, Birdwell (AI, CASCADE)

RPI, Frederick (AI for design)

UCSB, Laub (numerics)

LLNL, Petzold (DAE solvers)

General Electric

Companies (CTRL-C, Matrix$_X$, Matlab)
AI – Reasoning Systems, ADS, HP

IEEE CSS 3rd Symposium on CACSD

Visitors:

Mike Denham

Dean Frederick

The international contacts are very important for the continuation.

Problem: Expensive to travel.

SEMINARS AND VISITS
APRIL - NOVEMBER 1986

Sven Erik Mattsson and Karl Johan Åström

Department of Automatic Control
Lund Institute of Technology
Lund, Sweden

This is a list of seminars and external contacts the Department of Automatic Control, Lund Institute of Technology has had during the period April 1986 - November 1986, which are of interest for the CACE project. The list includes visits to the department and visits of the staff to companies and other universities, as well as participation in conferences, symposia, workshops, courses etc.

Our visitors are normally given a presentation of our department and our research, as well as live demonstrations of our packages for CACE (Simnon, Idpac etc.), so this is not explicitly mentioned in the list below.

April 15-18

Karl-Erik Årzén participated in the 1st International Conference on Applications of Artificial Intelligence in Engineering Practice held in Southampton, UK. Karl-Erik Årzén presented a paper titled "Expert Systems for Process Control".

April 20-22

Christos Georgakis, Department of Chemical Engineering, MIT visited our department. He gave a seminar on the use of expert system techniques for control of chemical processes.

April 23

Karl-Erik Årzén gave the seminar "Expertsystem för processreglering" at Perstorp AB in Perstorp.

April 24 - 25

Karl-Erik Årzén, Per Persson and Jan Eric Larsson participated in SAIS - 86 (The Swedish AI Society's Annual Workshop) in Linköping. Karl-Erik Årzén presented the paper "Kunskapsbaserade regulatorer" (Knowledge Based Controllers and Jan Eric Larsson and Per Persson presented the paper "Ett expertsystemsnitt för IDPAC" (An Expert System Interface for Idpac).

April 28

Professor W. Levine, University of Maryland visited the department and gave a seminar titled "Two examples of Computer Aided Control Systems Design using Delight/Marylin".

May 5

Dr Prasad Dhugarti, University of Delaware visited the department and gave a seminar titled "FALCON - An Expert System for Fault Diagnosis in Commercial Chemical Plants". Dr Prasad Dhugarti has worked on FALCON several years in cooperation with DuPont och Foxboro.

May 29 - June 5

Mr. Bob King, University of Salford, U.K. visited the department. He is the designer of the graphical operating system ARGOS. He gave a seminar titled "Introduction to ARGOS".

June 2

Professor Neil Munro, UMIST, Manchester, U.K. visited the department and gave a seminar "Comparison of Some CAD Facilities".

June 4

Rolf Braun demonstrated a laboratory set-up with the ASEA Master system.

June 11 - 29

Jan Eric Larsson (JEL) and Karl-Erik Årzen (KEÅ) visited USA. The main goal of the visit was the American Control Conference ACC in Seattle June 18 - 20 were Karl-Erik Årzén presented the paper "Use of expert systems in closed loop feedback control" and Jan Eric Larsson presented the paper "Knowledge Representation by Scripts in an Expert Interface". In connection with this several universities and companies were visited.

JEL visited Mark Nagurka, Assistant Professor in Mechanical Engineering at Carnegie-Mellon University in Pittsburgh. Among other things, Professor Nagurka demonstrated a simulation and animation program for lab processes. JEL also visited Mike Rychener, who works with a project using Knowledge Craft. He also visited Gordon Goetsch and Murray Campbell, working with Professor Hans Berliner developing the chess playing computer Hitech. KEÅ and JEL visited Phillip Brue at MIT AI Lab. in Cambridge. Dr. Brue showed the laboratory and different Lisp Machine alternatives were discussed. KEÅ and JEL visited Lowell Hawkinson at Lisp Machine Inc. in Cambridge. Dr. Hawkinson works in the Process System Division with the PICON system. KEÅ held a seminar on the Expert Control project and Michael Levine gave a demonstration of PICON.

KEÅ and JEL visited Prof. Mark Kramer at the Department of Chemical Engineering, MIT, Cambridge. Prof. Kramer works with using expert system techniques and qualitative reasoning for alarm analysis in chemical processes. KEÅ gave a talk on Expert Control and Prof. Kramer arranged several discussions. Layi Oyeleye described his work in qualitative reasoning. Greg O'Connor presented his ideas of expert control of a fermentation process and Prof. Georg Stefanopoulos briefly described his different expert system related projects.

KEÅ and JEL visited Dr. Richard Stenerson at the Avionics Information Group,

Boeing Military Airplane Co., Seattle. Dr. Stenerson works with expert systems in cockpit information presentation systems. They specially works with real-time blackboard based systems. KEÅ gave a talk on Expert Control and Dr. Stenersons group presented their work.

KEÅ and JEL visited John Anton at Reasoning Systems in Palo Alto. They work with the automatic programming tool Refine. Refine is a wide-spectrum language with program transformation rules for transformation from high-level Refine code to low-level Refine code and from that to the desired goal language. Currently only Lisp is supported as goal language but they are on their way with a C version. Larry Masinter gave a demonstration were Refine was used in a program development environment with information zooming. This project had much in common with Lics. KEÅ visited Dr. Gregory Gibbons at Systems Control Technology in Palo Alto. Systems Control has a project were they use an expert system as a part of the computer aided control system design package CTRL-C. KEÅ gave a talk on Expert control. KEÅ visited Dr. Chee-Yee Chong at Advanced Decision Systems (ADS) in Palo Alto. ADS works with several AI projects mainly for the US defence. They have developed the blackboard based expert system shell SOPE. KEÅ gave a talk on Expert Control and Michael Cation demonstrated SOPE.

JEL visited Mats Torkelsson, working with VLSI in the Department of Electrical Engineering at Berkeley. He also visited Jim Mayfield, a Ph.D. student working for Professor Robert Wilensky with the Unix Assistant, an intelligent help system for Unix. JEL also met Professor L. Zadeh. At Stanford University, JEL visited Professor Mike Genesereth, who had been working with expert systems and natural language. He also visited Professor Gene Franklin, who demonstrated several lab processes and presented his research group. JEL gave a seminar for Professor Franklin's group.

June 18

Bengt Mårtensson gave a seminar titled "Tools used for production of my PhD-thesis" with the contents

THMACRO - a superset (essentially) of BOOKMACRO
INDEX-handling
DVILW - postscriptgenerator for DVI-files
Interface to LaserWriter

HCOPY2PS - making POSTSCRIPT of Simnon (e.g.)
Inclusion of Simnon- and MacDraw-figures in TeX/POSTSCRIPT

June 24

Bengt Mårtensson gave a seminar titled "POSTSCRIPT - An Introduction".

July 1 - 3

The 2nd IFAC Workshop on Adaptive Systems in Control and Signal Processing was held at the Lund Institute of Technology. About 200 persons from all over the world participated. Posters presented the CACE projects at the department and many demonstrations were made during lunch and coffee breaks and in the evenings.

July 14 - 18

Karl Johan Åström, Sven Erik Mattsson and Dag Brück participated in the Joint SERC/STU Workshop on Graphical Front Ends for CACE held at UMIST, Manchester, U.K. Karl Johan Åström gave a presentation titled "Representation of System Connections". Sven Erik Mattsson and Dag Brück gave two presentations "Hierarchical Block Diagrams and Information Zooming" (including a video tape demonstrating the prototype simulator Hibliz). and "Representation and Visualization of Systems and Their Behaviour". Besides the formal presentations the workshop contained many useful discussions and gave many opportunities to informal exchange of information and ideas.

July 21 - 22

Karl Johan Åström and Sven Erik Mattsson visited Professor Jürgen Ackermann's group at DFVLR, Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt e.V., Oberpfaffenhofen (close to Munich). Karl Johan Åström gave a seminar titled "Adaptive Friction Compensation in Robot Drives". Sven Erik Mattsson presented the prototype simulator Hibliz and showed the video demo. They presented their work in the robotics and CACE areas. Of special intest for us is their robot animation and steering ball. Dr. Hirzinger has developed a steering ball with six degrees of freedom. It senses the forces and torques you apply to it using your hand. In the robot application they have used it in the following way: If you applied a force in the vertical direction the picture scrolled. Panning was done by applying a left or right horizontal force. Zooming in was done by pressing the ball in the horizontal direction and zooming out by

pressing the ball in the reverse direction. Torques made the object on the screen rotate. This application of the steering ball is very natural and easy to use. It is a terrific input device that can make graphics workstations more powerful. We have ordered a ball for our IRIS.

August 4 - 22

We had a Symbolics 3640 on loan from Nokia. Christer Nilsson, Nokia gave an introduction on August 4 - 5.

August 12-14

Bengt Mårtensson presented the paper "Integrating different symbolic and numeric tools for linear algebra and linear systems analysis" (by Ulf Holmberg, Mats Lilja and Bengt Mårtensson) at SIAM Conference on Linear Algebra in Signals, Systems and Control, August 12-14, 1986, Boston, Massachusetts, USA.

August 27-30

Karl Johan Åström visited Zürich to participate in a meeting with the IFAC council and to participate in an IFAC Symposium on Large Scale Systems. He chaired and gave an introductory presentation for a round table discussion on AI in Automatic Control. He also visited ETH.

September 3

Karl Johan Åström gave a survey on programs from ETH.

September 1-5

Professor Brian Anderson Australian National University, Canberra visited the department. He gave a seminar titled "Discussion on control trends and good research topics".

September 12

Dr Linda R. Petzold, Lawrence Livermore National Laboratory, California, USA gave a seminar titled "Numerical ODE Methods for Nonlinear Differential/Algebraic Systems" at the Department of Computer Science and Computer Engineering. She visited our department in the afternoon.

September 15-16

Sven Erik Mattsson and Thomas Schönthal attended the course "ACSL, Advanced

Continuous Simulation Language" at Volvo Data, Torslanda. The course was held by Joe Gauthier, Mitchell and Gauthier Associates.

September 17 - October 24

Karl Johan Åström visited USA. On September 18-19, he participated in the IEEE Workshop on The Challenge to Control, Santa Clara, CA where he gave the Keynote Talk.

On September 24-26 he participated in the IEEE CSS Third Symposium on Computer-Aided Control System Design (CACSD), Arlington, Virginia. He presented the pappers "System Representations" by Åström, K.J. and W. Kreutzer and "A Simulator for Dynamical Systems Using Graphics and Equations for Modelling" by Elmqvist, H. and S.E. Mattsson. He introduced a panel discussion on AI and Automatic Control.

He visited DuPont, Delaware to discuss advanced process control and gave a seminar titled "AI as a Tool for Control System Design".

In California he visited Advanced Decision Systems, HP Research, UC Berkeley, UC Santa Cruz, Reasoning Systems, Integrated Systems, Apple, IBM, Systems Control.

September 26

At the Department of Computer Engineering, Dr. John H. Howard, Information Technology Center, Carnegie-Mellon University, Pittsburgh, USA gave a seminar titled "ANDREW - A distributed personal computing environment at Carnegie-Mellon University, Pittsburgh"

September 29-30

Karl-Erik Årzén and Per Persson visited Inference AB in Uppsala to discuss LMI Lispmachines. They also visited Dr. Rune Gustafsson at SICS (Swedish Institute for Computer Science) in Kista, Stockholm. The purpose of the visit was to discuss their experiences of different Lisp machines. A seminar on CACE was also given. Texas Instruments in Stockholm was visited on September 30. The goal for this visit was to discuss Texas Lisp machines.

October 1

Per Sahlin and Joakim Hollmer, ITM (Gustaf Söderlind's coworkers) visited the department to discuss the design and implementation of a simulator for climate control applications.

October 6-8

Dag Brück went to the Unix Exhibition, Stockholm. He attended a full-day seminar on object-oriented design. At the exhibition he discussed workstations with Ericson (SUN), Domain Computer (Apollo), NORDCOMP, CADMUS and HP. He also visited the Swedish Institute for Computer Science. Among other things he discussed SUN workstations and Lisp with Hans Eriksson and Lennart Fahlén.

October 7

Vikram Kaul, STFI visited the department. We discussed the use of AI - and expert system techniques to implement supervision in the process industry. STFI has plans to start a STU-supported project in this area in 1987.

October 14

Andrew R. Koenig, AT&T Bell Laboratories and Barbara E. Moo, AT&T visited the department. Andrew Koenig gave a seminar titled "An overview of C++".

October 21

Karl-Erik Årzén participated in Svenska Mekanförbundet's steering committee meeting on Knowledge Based Systems in Linköping.

November 6 - December 8

Professor Mike Denham, Kingston Polytechnic visited the department.

November 19

Dag Brück gave a seminar titled "Implementation of Graphics for HIBLIZ" at the Department of Computer Science and Computer Engineering.

Published Papers, Conference Contributions and Reports

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Report

on

The Joint SERC/STU Workshop

on

Graphical Front Ends for CACE

held at

UMIST

Control Systems Centre

14-18 July 1986

Professor N. Munro & Professor K.J. Astrom

1. INTRODUCTION

The purpose of the Workshop was to address the questions of:

(i) Graphical Facilities

(ii) User Interface

(iii) Environments

(iv) Future Directions

A specific goal was to provide input to the proposed ECSTASY environment. Part of the time was devoted to presentation of on-going and planned work. There were also presentations aimed at giving proper inputs from related areas, like graphics standardisation, workstations and AI environments. Time was also allowed for discussions and working groups.

The detailed program is enclosed in Appendix A.

The participants, Appendix B, represented the SERC sponsored research groups, RAL and industry. There was unfortunately only a limited representation of small and medium sized industry. The participants covered a good spectrum of control engineers, theoreticians, systems engineers, software engineers and computer scientists.

The Workshop provided a good forum for exchange of ideas. There were frank and lively discussions. The comments and contributions from the industrial representatives were particularly useful. The discussions indicated that it was difficult to separate graphics facilities and user interfaces from several other considerations. Towards the end of the Workshop the discussion focussed on the elements that were deemed useful as a core environment. These ideas which are summarised in the next section were presented and discussed during the last day of the Workshop.

2. MAIN FINDINGS

The following paragraphs report the main findings of the Workshop which have emerged from the various presentations and intensive discussions on Graphics Facilities and the User Interface.

Three major requirements perceived for the ECSTASY infrastructure were:-

(a) A Database Management System
(b) A GKS Graphics Kernal
(c) A Window-Manager (machine independent)

These tools are not unique to CACE. They are expected in many computing environments.

2. MAIN FINDINGS (continued) Page 2

Commercially available packages which may satisfy the above needs exist and should be explored. Items (b) and (c) can be provided by RAL as part of SERC's Common Base Policy and possibly also (a). Again, these must be examined.

Within the area of Graphics Facilities and the User Interface, the following requirements were indicated:-

System Data Input and Manipulation

Here a need for the entry of system descriptions in block schematic form as a descriptive approach also useful for report generation was identified. The ability to enter system descriptions in block diagram/signal-flow graph form was required to allow for simulation representation of systems described by transfer-functions and nonlinear elements. Facilities for the construction of complex systems from simple blocks and the reduction of several simple blocks into an equivalent sub-system block (with block-nesting capability) were required. These facilities were also needed for system analysis purposes.

The manipulation of graphs both in descriptive (i.e. identifying objects) and symbolic form was required. The latter category would include differential equation representations, vector-matrix equations, various representations of nonlinear elements in the form of graphs, tables or code, with the additional ability to perform transformations on both the linear and non-linear representations.

Signal Generation

Generators to create various time-domain and frequency-domain inputs to stimulate a system or sub-system in order to establish its characteristics are needed.

Signal Analysers

Devices for analysing signals (i.e. their max, min, spectra, covariances), and to carry out curve-fitting were needed. A requirement for various tools to perform parametric and non-paramatric identification on time-series data describing systems or system components was expressed.

2. MAIN FINDINGS (continued)

Graphical Output

The ability to display both time-response and frequency-response information, including the output from 'software instruments', was necessary. This would obviously include the ability to draw Nyquist, Nichols, and Bode type plots, and derived outputs such as the root-locus diagram, spectral responses and correlation functions. An important requirement here is the ability to carry out signal conditioning operations and interactively interrogate the various graphical representations using a pointing device. The monitoring and displaying of appropriate status and error messages were also considered important. Some ability to provide rudimentary 3-D graphics was also needed. A strong interest in the ability to introduce animation was expressed.

Diary Facility

Some means of data storage of the various records arising from a problem study were required, with the ability to re-trace back through these records and re-run or restart a problem from a previous datum point.

Linkage

A set of facilities to provide a good linkage between the graphical activities and the command language and vice-versa were needed.

3. KEY DISCUSSION POINTS

The hardware that the core system was targeted on was subject to much discussion. Several university groups were quite happy to use SUN and UNIX. Several industry representatives advocated strongly that such an initial direction would limit the industrial use since many industries were using mainframes, VAX/VMS and Tektronix type terminals. Some university groups also shared this view. Examples of small companies using work-stations were mentioned. The RAL representatives said that porting of properly done software from SUN to VAX systems was a routine matter. One possibility to quickly bring the core system to industry was to have a few portable SUN's available for loan.

The necessity of providing good documentation was emphasised.

18.7.86.

Professor Åström has asked that circulation of this document be restricted to the Management Committee only.

STU INVOLVEMENT

K. J. Åström

The involvement of the Lund team in the long and short range aspects in the projects will have to be confirmed with the Management Committee of the STU program. Below are some preliminary personal viewpoints:-

1. General Directions

   The Swedish project has a more long range scope since it covers advanced graphics, object oriented programming, symbolic computation and expert system interfaces. We have found the interaction with the SERC program very beneficial since it has widened our scope and brought us into contact with several groups which we would not otherwise have interacted with.

2. Possible Interaction with the Core Environment

   It would be posible to convert some of the existing Lund packages e.g. Simnon and Idpac to run with the planned core environment. This is compatible with current plans to implement the Lund packages on workstations. We may also consider attaching the Lund packages to the EAGLES environment.

   Provided that SERC goes the SUN/UNIX route, we would then jointly have a unique experience base.

   We could probably also provide some useful input to the planned man/machine interface. Our current graphics based MMI cannot be ported to a SUN because of the computing power required. Some of the ideas used in our interface may however be useful.

3. Long Range

   The current work at Lund on systems representations has links to the database work at Cambridge. It may be beneficial to have a closer interaction in that area.

   The work on the man/machine interface at Lund will be moved to an object-oriented Lisp environment. This will make prototyping easier and it will also allow a good access to the results from our project on expert system interface.

   The Lund project can also benefit considerably from a direct interaction with CEGB on their mimic diagrams and animation.

STU INVOLVEMENT (continued) Page 2

3. Long Range (continued)

The activities on the system descriptions and the MMI at Lund may form the basis for the second generation of the graphics interface.

There were also some interesting problems on system restructuring that may conveniently be carried out in our frame-work.

18.7.86.

Joint SERC/STU Workshop

on

Graphical Front Ends for CACE

to be held at

UMIST

Control Systems Centre

14-18 July 1986

The workshop will address the following specific areas of Computer Aided Control Engineering:-

1) Graphical Facilities

2) User Interface

3) Environments

4) Future Directions

Various discussion periods have also been provided with the aim of producing a final report and workplan on the first two of these specific aspects and their impact on the proposed ECSTACY environment.

Please Note:- All speakers are asked to allow 15 to 20 minutes at the end of their talk for immediate discussion of their presentation.

Professor N. Munro

Programme

Monday 14th

9.15- 9.30		Introduction N. Munro (UMIST)
9.30-10.30	1.	Presentation of System Connections K J Astrom (Lund Institute of Technology)
10.30-11.00		Coffee
11.00-11.45	2.	Signal Flow Graph System Descriptions N Munro & M Griffiths (UMIST)
11.45-12.30	3.	A Graphical Input Interpreter C Downes (Salford)
12.30-14.00		Lunch
14.00-15.00	4.	Hierarchical Block Diagrams S E Mattsson (Lund)
15.00-15.45	5.	A Graphics Environment for CACSD A Hatzigaidas (Salford)
15.45-16.15		Tea
16.15-18.00		Demonstrations
18.30-19.30		Dinner

Tuesday 15th

9.00-10.30	1.	Preliminary Discussions on Graphical Facilities
10.30-11.00		Coffee
11.00-11.45	2.	Representation and Visualization of Systems S E Mattsson & Dag Bruck (Lund Institute of Technology)
11.45-12.30	3.	A Graphics Descriptive Environment R King (Salford)
12.30-14.00		Lunch
14.00-14.45	4.	Types of User Interface J M Edmunds (UMIST)
14.45-15.30	5.	An Intelligent Graphics MMI A Barker (Swansea)
15.30-16.00		Tea
16.00-16.45	6.	Adaptive Dialogue Facilities N Munro & Z Palaskas (UMIST)
16.45-18.00		Demonstrations
18.30-19.30		Dinner

Wednesday 16th

9.00- 9.45	1.	Preliminary Discussion on User Interface
9.45-10.30	2.	CEGB Plant Analyser/Mimic Diagrams M Whitmarsh-Everiss (CEGB)
10.30-11.00		Coffee
11.00-11.45	3.	Graphics standards : GKS & PHIGS D Sutcliffe (Rutherford-Appleton Lab)
11.45-12.30	4.	Graphics workstations J Gallop (Rutherford-Appleton Lab)
12.30-14.00		Lunch
14.00-14.45	5.	Dialogue Tools/Panels & Editors S Goodfellow (SUN)
14.45-15.30	6.	Discussion on User Interface
15.30-16.00		Tea
16.00-18.00	7.	Working Groups on Graphics Facilities and User Interface
18.30-19.30		Dinner

Thursday 17th

9.00-10.30	1.	CACE Requirements D Atherton (Sussex)
10.30-11.00		Coffee
11.00-11.45	2.	Features of Existing Packages N Munro (UMIST)
11.45-12.30	3.	Environments for Control System Design M Denham (Kingston Polytechnic)
12.30-14.00		Lunch
14.00-15.30	4.	Discussion on Environments
15.30-16.00		Tea
16.00-18.00	5.	Working Groups on Graphics Facilities and User Interface
18.30-19.30		Dinner

Friday 18th

9.00-10.30	1.	Report of Working Groups
10.30-11.00		Coffee
11.00-11.45	2.	Languages - COMMONLISP, LOOPS, FLAVORS R. Easterby (Artificial Intelligence Limited)
11.45-12.30	3.	Data-Type Structures P Brewer (Cambridge)
12.30-14.00		Lunch
14.00-15.30	4.	Short and Long Term Directions
15.30-16.00		Tea
16.00		Close & Departure

Software Demonstrations

These have been initially arranged on a day-to-day basis and will take a variety of forms. Some groups will provide on-line demonstrations using the 2 x SUN-3 machines and 2 x SUN-2 machines available in the department along with the ICL PRIME-9955, ICL-PERQ, and Sigma and Tektronix colour-graphics terminals. There will also be live demonstrations and a poster-session of CEGB's activities, and various video-tape presentations.

A simple schedule of suggested access to these various facilities is shown below:-

Provisional Schedule

Monday	(16.15-18.15):	UMIST Lund Salford
Tuesday	(16.45-18.15):	Lund Salford UMIST Swansea
Wednesday		CEGB R.A.L. SUN
Thursday Friday	}	Any/All of the above, and possibly A.I. Ltd.

Contacts: Dr. Edmunds, Dr. Bowe

IEEE CONTROL SYSTEMS SOCIETY
Third Symposium on Computer-Aided Control System Design
Quality Inn–Pentagon City
Arlington, Virginia

PROGRAM

TUESDAY, SEPTEMBER 23

1:00–5:00p	CSS TECHNICAL COMMITTEE ON CACSD/WORKING GROUP MEETINGS
5:00–8:00p	REGISTRATION
6:00–8:00p	WELCOMING RECEPTION

WEDNESDAY, SEPTEMBER 24

7:00–10:30a	REGISTRATION
8:30– 9:00a	OPENING REMARKS
9:00–10:00a	PLENARY SESSION
	SESSION 1: ROBOTICS I—Chairman: Roy Olsen, Grumman Corporation
10:00–10:30a	"Kinematic Algorithms for Real-Time Robot Control"—M.H. Ang, Jr. and V.D. Tourassis; University of Rochester
10:30–11:00a	"Computer-Aided Robotics Control System Design"—A. Orbach and S. Myers; Martin Marietta
11:00–11:30a	"Computer-Aided Development of Robot Vision Control Algorithms"—E. Byler and J. Lehman; Grumman Corporation
	SESSION 2: ROBOTICS II—Chairman: Richard Gran, Grumman Corporation
1:00–1:30p	"Control of a Flexible Arm: Design and Implementation"—G.H. Frank, L. Wang, P.S. Krisnaprasad; University of Maryland
1:30–2:00p	"Simulation of Telerobotic Systems"—F.W. Harrison; NASA/Langley Research Center
2:00–2:30p	"Computer-Aided Modeling and Control of Robotic Manipulators"—H. Asare; Rockwell International Corporation
2:30–3:00p	BREAK
	SESSION 3: SOFTWARE ARCHITECTURES—Chairman: J.D. Birdwell, University of Tennessee
3:00–3:30p	"System Representations"—K.J. Aström; Lund Institute of Technology and Wolfgang Kreuter; University of Canterbury
3:30–3:45p	"An Object Oriented Approach to CACSD"—P. Phaal; Cambridge University
3:45–4:15p	"Software Practices in CACSD: A Need for Tool-Based Systems"—M. Wette and A.J. Laub; University of California
4:15–4:45p	"SCEW: Window-Based Software for Interactive Control Systems Analysis and Design"—B.H. Krogh and C.P. Neuman; Carnegie-Mellon University

THURSDAY, SEPTEMBER 25

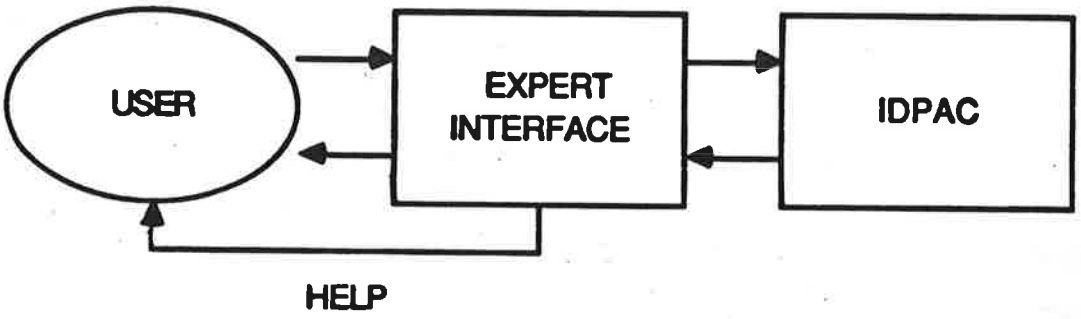
	SESSION 4: CACSD PACKAGES I—Chairman: William S. Levine, University of Maryland
8:45–9:00a	"MATLAB and Control Design on the Macintosh"—J.N. Little, S. Herskovitz, A.J. Laub and C.B. Moler; The Math Works, Inc.
9:00–9:15a	"Automated Synthesis of Ada Real-Time Control Software"—L.L. Lehman, S. Houtchens, M. Navab and S.C. Shah; Integrated Systems Inc.
9:15–9:30a	"The Different Modeling Capabilities of IMPACT"—M. Rimvall, Swiss Federal Institute of Technology
9:30–10:00a	"Some Remarks About the Design of an Interactive CACSD Package: The Blaise Experience"—F. Delebecque; Institut National de Recherche en Informatique et en Automatique
10:00–10:30a	BREAK
	SESSION 5: CACSD PACKAGES II—Chairman: Gary A. Hewer, Naval Weapons Center
10:30–11:00a	"CAEBEL–A Computer Aided Control Systems Synthesis and Analysis System"—K.L. Lawrence, C.C. Blackwell, D.A. Hullender, A.L. Blackwell, J.K. Nisbett and C.C. Ku; University of Texas
11:00–11:30a	"Working with CAE Software from Other Disciplines"—B. Schrick; Systems Control Technology, Inc.
11:30–12:00n	"FlexCAD: Prototype Software for Modelling and Control of Flexible Structures"—W.H. Bennett and N. Barkakati; Systems Engineering, Inc.
12:00–2:00p	LUNCHEON/LUNCHEON ADDRESS—Speaker: Lt. Col. Robert Van Allen, United States Air Force
	SESSION 6: CACSD PACKAGES III—Chairman: Larry J. Levy, John Hopkins University
2:00–2:30p	"ODESSYS: ODE Simulation System for Nonlinear Optimization, Controls and Differential Games"—W.J. Grantham; Washington State University
2:30–2:45p	"Interactive Kalman Filter Analysis and Design Package"—R.S. Baheti; General Electric Company
2:45–3:15p	"A Real-Time Workstation for Computer-Aided Design and Implementation of Control Systems"—M.E. Stieber; Communications Research Center and C. Schmid; Rubr-Universität Bochum
3:15–3:30p	"A Concept for Mostly Automatic Implementation of Control Algorithms"—H. Hanselmann; University of Paderborn
3:30–4:00p	BREAK
	SESSION 7: ALGORITHMS—Chairman: Andre L. Tits, University of Maryland
4:00–4:20p	"CACSD Using the State-Space L∞ Theory"—M.G. Safonov and R.Y. Chiang; University of Southern California
4:20–4:40p	"Nondifferentiable Optimization in Worst Case Control Systems Design: A Computational Example"—D.M. Stimler and E. Potak, University of California
4:40–5:00p	"Computer-Aided Stability Analysis Renders Popov Criterion Obsolete"—M.G. Safonov and G. Wyetzner; University of Southern California
5:00–5:20p	"The Integration of Coupled Discrete-Time Riccati Equation: An Algorithm"—R.J. West; ELAC Systems
5:20–5:40p	"On the Numerical Solution of the Discrete-Time Algebraic Riccati Equation"—P.Hr. Petkov, N.D. Christov and M.M. Konstantinov; Higher Institute of Mechanical and Electrical Engineering

FRIDAY, SEPTEMBER 26

	SESSION 8: BENCHMARKS & SIMULATION—Chairman: Terry J. Brennan, The Aerospace Corporation
8:30–8:45a	"IEEE Benchmarks for CACSD Packages"—D.K. Frederick; Rensselaer Polytechnic Institute and M. Rimer; Grumman Aerospace Corporation
8:45–9:00a	"Two Sets of Benchmark Problems for CACSD Packages"—P.A. Hawley and T.R. Stevens; Johns Hopkins University
9:00–9:30a	"A Large Distributed Aircraft Engine Simulator"—H.A. Spang, III, J. Bedand and M. Godula; General Electric
9:30–10:00a	"A Simulator for Dynamical Systems Using Graphics and Equations for Modelling"—H. Elmquist; SattControl AB and S.E. Mattsson; Lund Institute of Technology
10:00–10:30a	BREAK
	SESSION 9: ARTIFICIAL INTELLIGENCE I—Chairman: Gilmer Blankenship, University of Maryland
10:30–10:45a	"An Expert System for Computer-Aided Linear Multivariable Control System Design"—G.K.H. Pang, J.M. Boyle and A.G.J. MacFarlane; Cambridge University
10:45–11:00a	"An Adaptive CACSD Dialogue Facility"—N. Munro and Z. Palaskas; Control Systems Centre and D.K. Frederick; Rensselaer Polytechnic
11:00–11:30a	"ACOLADES: A Control Law Designing Expert System"—T.L. Trankle, J.D. Pehoushek and P. Sheu; Systems Control Technology
	SESSION 10: ARTIFICIAL INTELLIGENCE II—Chairman: Rowland Johnson, Lawrence Livermore National Laboratories
1:00–2:30p	Panel Discussion: John R. James, U.S. Military Academy; James Taylor, General Electric; Lofti Zadeh, University of California, Berkeley; Terry Cline, Hewlett Packard; Rowland Johnson, Lawrence Livermore National Laboratories
2:30–3:00p	BREAK
	SESSION 11: APPLICATIONS—Chairman: Malcolm D. Shuster, Business and Technological Systems, Inc.
3:00–3:30p	"Interactive Computer Aided Analysis and Design of Energy Efficient Metro Tunnel Trajectories"—S. Lafortune; McGill University and M.P. Polis; Ecole Polytechnique
3:30–4:00p	"Application of Linear Quadratic Gaussian (LQG) Digital Control to Combat Armored Vehicle Technology"—J. Groff and T. Perkins; Aberdeen Proving Ground and M. Krok; General Electric Company
4:00–4:30p	"Predictive Control of Sewage Pumps"—P.C. Tan and K.P. Dabke; Monash University
4:30p	CLOSING REMARKS

Problem

How does one combine a CAD package **and** an expert system?



Solution

Use the expert system as a "command spy" interface in an intelligent help system!

Scripts

- Different constructs

  command
  production system call
  script procedure
  repetition
  or
  all

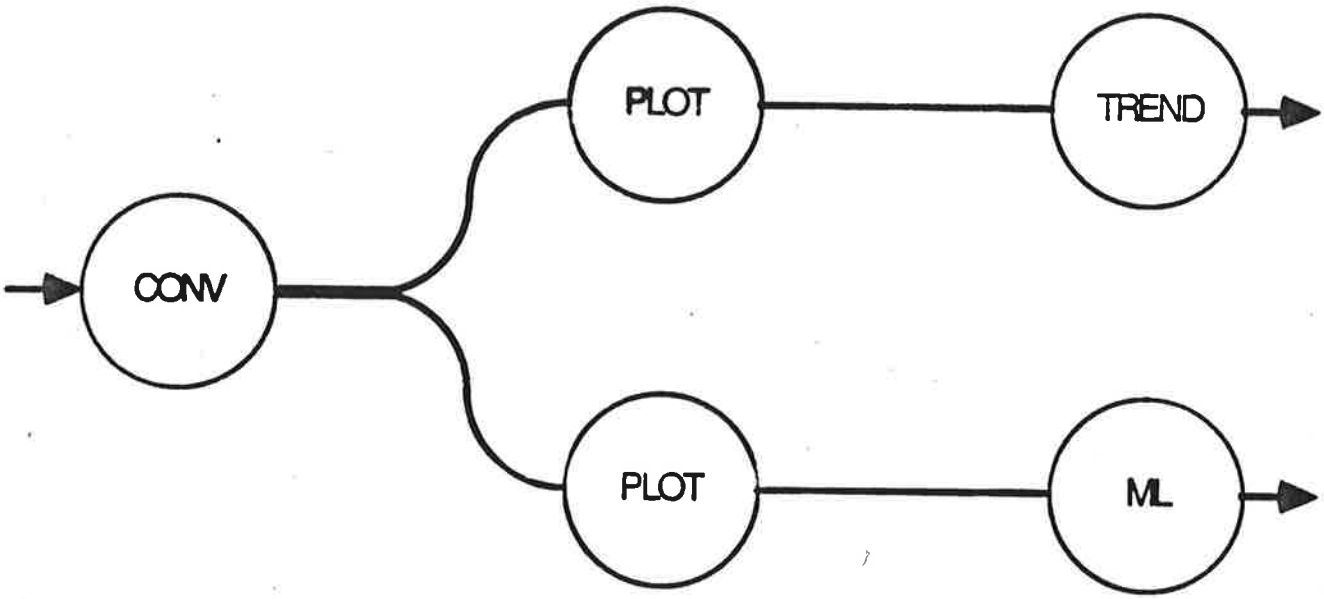
```
(conv
 plot
 trend
 (repeat (
   ml
   (repeat (
     (or (resid) (sptrf bode))))))
 stop)
```

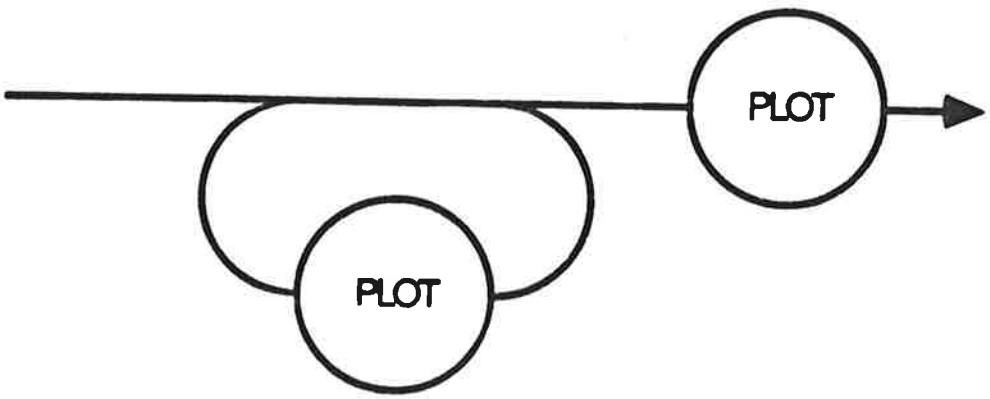
Example

```
((command conv DATA-T INDATA)
 (command plot DATA-T)
 (command trend DATA DATA-T)
 (command plot DATA)
 (kscall (data-cleaning-done))
 (repeat (
   (scriptprocedure ml-procedure
     (in DATA) (out SYST RES))
   (scriptprocedure examine
     (in SYST RES) (out FREQ))))
 (kscall (estimation-done))
 (command stop))


(ml-procedure
  (in DATA) (out SYST RES)
  (command ml SYST DATA)
  (command resid RES SYST DATA))


(examine
  (in SYST RES) (out FREQ)
  (all
    ((command plot RES))
    ((command sptrf FREQ SYST)
     (command bode FREQ))))
```

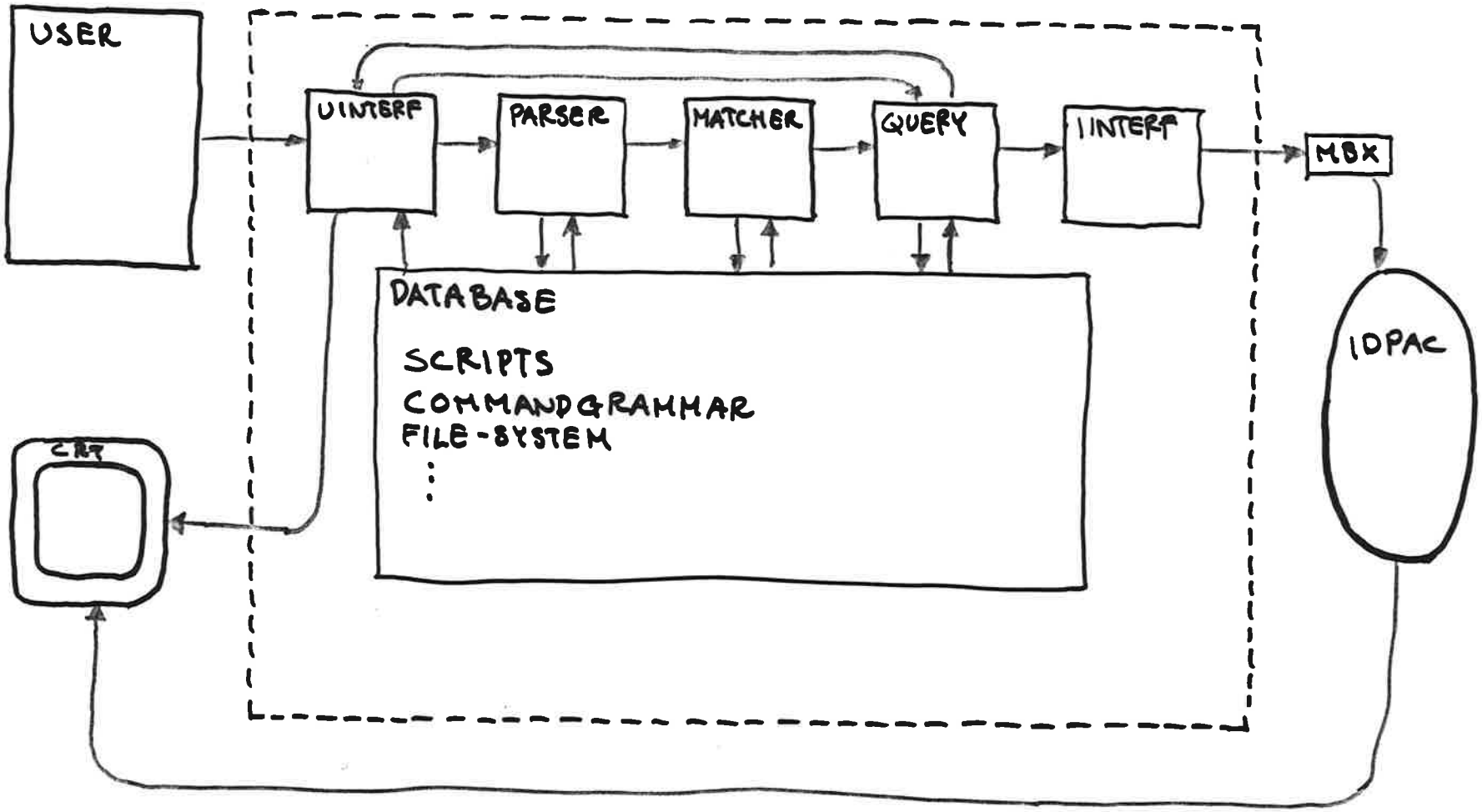
Script Matching

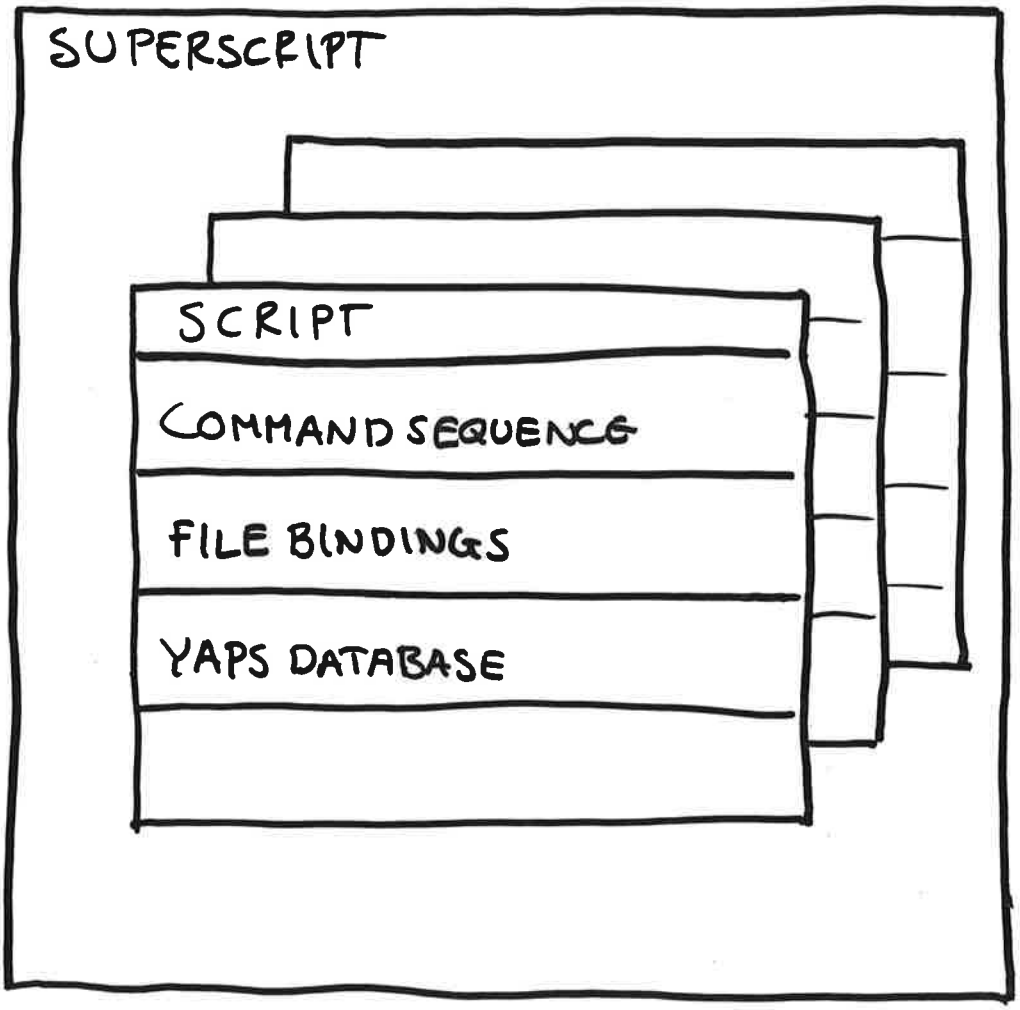
- The script language is very general.
- The users will develop new scripts.
- Pattern matching.





EXPERT SYSTEM INTERFACE




SUPERSCRIPT
SCRIPT
COMMAND SEQUENCE
FILE BINDINGS
YAPS DATABASE

Conclusions

- Use the expert system as a "command spy"
- Partition the knowledge base

  Scripts — command sequences
  Rules — system identification

Project: Numerical Solution of Differential - Algebraic Systems

Anders Barrlund (grad. student)

Bo Kågström (PI)
University of Umeå

Model of the Dynamic System:

$$g(t, x', x, v, p, c) = 0$$

- t: time
- x: unknown variables
- v: contains variables which do not appear differentiated in the equations
- p: simulation parameters (known)
- c: known constants

components of x appear differentiated

Main topics

- improve the robustness of D/A codes

  concentrate on DASSL [Petzold]

  * analyzing the (local) index
  * ill-conditioned systems and scaling
  * detection and dealing with discontinuities in the solution

- theoretical insights in higher index D/A-systems and their solution

$$A(t)\,x'(t) + B(t)\,x(t) = f(t)$$

  * questions on existence and uniqueness of solutions
  * standard canonical forms and analytic and numerical solutions
  * sensitivity of the soln for small perturbations

DASSL [Linda Petzold]

Solves a fully implicit D/A-system.

$$G(t, y, y') = 0$$

$$y(t_0) = y_0$$

$$y'(t_0) = y_0'$$

User provides a routine for the residual

$G(t, y, y')$ (all arguments known)

y_0' required to get a good starting approx. to Newton iteration

k-th step BDF-method:

$$t_n = t_{n-1} + h \qquad \text{(constant stepsize)}$$

$$y'(t_n) \approx \sum_{i=0}^{k} \alpha_i \, y_{n-i} / h$$

Solve

$$G\left(t_n, y_n, \sum_{i=0}^{k} \alpha_i \, y_{n-i} / h\right) = 0$$

for y_n ! (Newton iteration formula)

> Jacobian $G_y + \frac{\alpha_0}{h} G_{\dot{y}}$
> must be non-singular at t_n

Note:

- variable stepsize as well ($h := h_i$)
- Jacobian matrix represents an analog of $B + \lambda A$ for nonlinear-systems ($B = G_y$; $A = G_{\dot{y}}$)

Analyzing the (local) index.

Local index ν_k of $G(t, y', y) = 0$ at t_k is the index of the linearized problem at $t = t_k$.

$\Rightarrow$ If $A := G_{\dot{y}}\,]_{t=t_k}$, $B := G_y\,]_{t=t_k}$

then

ν_k = dimension of the largest Jordan block corresponding to the ∞-eigenvalue of $B+\lambda A$ ($B+\lambda A$ must be regular)

endif

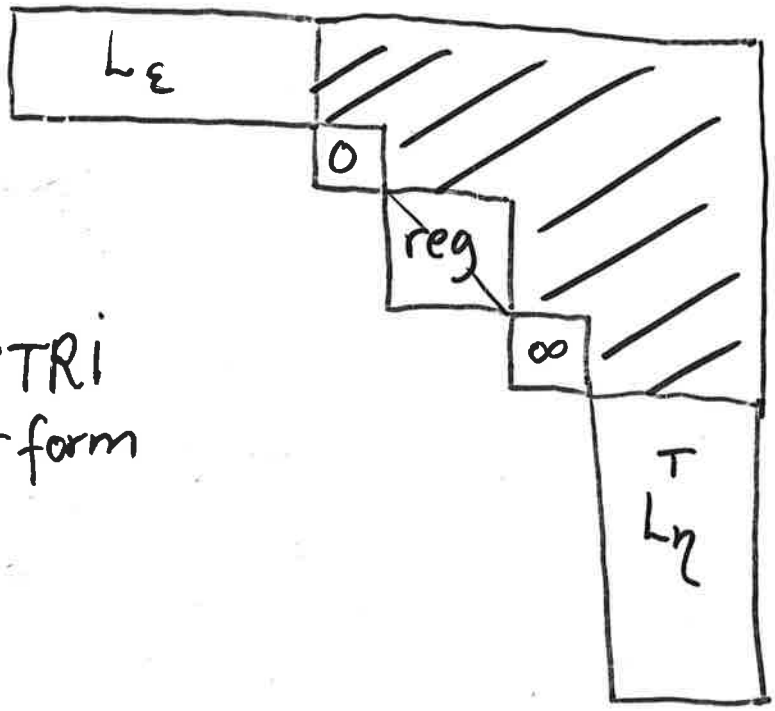
ν_k is computed or a singular $B+\lambda A$ is dected by computing the Kronecker structure of $B+\lambda A$ [GUPTRI with errors bounds, Demmel - Kågström]

(6)

Algoritmer

RGQZD

$$V^H (A + E - \lambda (B + F)) Q =$$



GUPTRI
-form

Input:
epsu =
uncertainty
in A and B
(tolerance for
deleting small
σ_i's)

reg ? ordered

V, Q unitary

$$\theta_{max}(P, P_{EF}) \leq ?$$

$$\theta_{max}(Q, Q_{EF}) \leq ?$$

Implementation in DASSL

Local index is always computed at the starting point and checked against info(16) (= integer set by the user)

If local index ≥ info(16) then DASSL returns (on output: info(16) = computed local index)

Error message: Local index at starting point is too high!

If DASSL fails (task interrupted with negative idid) then local index is computed at actual point of time

Error message: Local index as big as x when the code failed!

(8)

Analyzing the index (con't):

$$G(t, y', y) = A(t)y' + B(t)y - f(t)$$

Reduction Algorithm:

1. If A is nonsingular the reduction process is comple

2. Otherwise, premultiply G by nonsing. P(to zero out a maximal numbers of rows of A, and permute the 0-rows to the bottom:

$$\begin{bmatrix} A_{11} \\ 0 \end{bmatrix} \dot{y} + \begin{bmatrix} B_{11} \\ B_{12} \end{bmatrix} y = \tilde{f}(t)$$

3. Differentiate the bottom half of the system to obtain a new system

$$\begin{bmatrix} A_{11} \\ B_{12} \end{bmatrix} \dot{y} + \begin{bmatrix} B_{11} \\ \dot{B}_{12} \end{bmatrix} y = \tilde{\tilde{f}}(t)$$

Go to 1.

(Global) Index of a solvable linear system (with no turning points, local index changes, or changes in the structure of the system) is ν

$\Longleftrightarrow$

Reduction algorithm terminates in ν iteratio

Note:

⊖ if a system is not solvable the algorithm will not terminate

⊖ assumption: $\exists$ nonsingular $P(t)$ and $Q(t)$ to transform to SSCF

⊕ can be applied to nonlinear problems if $\dot{y}$ occurs only linearly:

$$A(t)\dot{y} + B(t,y) = 0$$

None of these restrictions in our approach!

(10)

Ill-conditioned linear systems and scaling

For each time-step DASSL solves a nonlinear system (modified Newton's method)

Iteration matrix:

$$JG = G_{\dot{y}} + \alpha G_y \qquad \alpha \sim O(h)$$

JG is factored and used as many time-steps as possible.

Problem: JG close to singular if $G_{\dot{y}}$ singular and α small

Possible remedy: Scaling

* someone who knows the problem
→ * row equilibration
→ * constant scaling of some rows ($\cdot \alpha^{-1}$)

$$\begin{bmatrix} A_1(t) \\ 0 \end{bmatrix} y'(t) + \begin{bmatrix} B_1(t) \\ B_2(t) \end{bmatrix} y(t) = f(t) \Rightarrow JG = \begin{bmatrix} A_1(t) + \alpha B_1(t) \\ \alpha B_2(t) \end{bmatrix}$$

60

Scaling (con't)

Results so far:

* never managed to solve any problem that DASSL could not solve without scaling
* very small improvements in the computed solution

"Possible Explanation":

Scaling only improve/decrease the errors due to the finite precision. Normally they are small compared to truncation errors.

Detection and dealing with discontinuities

Only started to get experiences from DASSL applied to D/A-systems with discontinuities in the solution.

- discontinuities in $y(t)$:

ex) $$y(t) = \begin{cases} 3 & t \leq 1 \\ 4 & t > 1 \end{cases}$$

- discontinuities in $y'(t)$?

ex) $$y(t) = \begin{cases} 25 & t \leq 1 \\ 24+t & t > 1 \end{cases}$$

- discontinuities in higher derivatives ?

Higher index linear constant coefficient D/A-system

(0) $\quad A\,x'(t) + B\,x(t) = f(t)$

A, B $n \times n$, $\quad A$ singular

Solvability $\Longleftrightarrow$ $B+\lambda A$ is regular

$(\det(B+\lambda A) \not\equiv 0)$

Standard Canonical Form, SCF: $\exists\, P, Q$ non-sing:

$$PAQ = \begin{bmatrix} I & 0 \\ 0 & N \end{bmatrix} \qquad PBQ = \begin{bmatrix} C & D \\ 0 & I \end{bmatrix}$$

N nilpotent of degree ν; $N^{\nu-1} \neq 0$, $N^{\nu} = 0$

Index of (0): ν = dimension largest Jordan block of N (∞-eigenvalue)

$x = Qy$, premult P:

$$\begin{bmatrix} I & 0 \\ 0 & N \end{bmatrix} \underbrace{\begin{bmatrix} y_1'(t) \\ y_2'(t) \end{bmatrix}}_{y'(t)} + \begin{bmatrix} C & 0 \\ 0 & I \end{bmatrix} \underbrace{\begin{bmatrix} y_1(t) \\ y_2(t) \end{bmatrix}}_{y(t)} = \begin{bmatrix} f_1(t) \\ f_2(t) \end{bmatrix}$$

Higher index: $\nu \geq 2$ $\qquad \nu = \mathrm{Ind}(A, B)$

$$y_1'(t) + C\, y_1(t) = f_1(t) \qquad \text{state-var. system}$$

$$N y_2'(t) + y_2(t) = f_2(t) \qquad \text{algebraic system}$$

Closed form solution (analytic):

$$y_1(t) = e^{-(t-t_0)C} \cdot x_1(t_0) + \int_{t_0}^{t} e^{(s-t)C} \cdot f_1(s)\, ds$$

$$\boxed{y_2(t) = \sum_{i=0}^{\nu-1} (-N)^i f_2^{(i)}(t)}$$

$$= f_2(t) - N \cdot f_2'(t) + N^2 \cdot f_2''(t) + \cdots + (-N)^{\nu-1} f_2^{(\nu-1)}(t)$$

$x_1(t_0)$ arbitrarily

Consistent initial conditions must satisfy $y_2(t)$!

Note the role of the index ν!

What about time-dependent systems.... ??

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Higher index linear time varying D/A-systems

(1) $A(t)\,x'(t) + B(t)\,x(t) = f(t)$

A, B $n \times n$, $A(t)$ singular for all $t \geq 0$

(singular linear systems, descriptor systems)

Applications: e.g. in optimal control problems, singular perturbation problems, electric circuit probl

Solvability:

(1) is <u>analytically solvable</u> on $I=[0,T]$:
if $\forall$ sufficiently smooth $f(t)$ solutions to (1) $\exists$ and are uniquely determined by there values at any $t_0 \in I$

[Campbell-Petzold]

Turning points:

Points where the solution fail to exist or to be unique (i.e. the dimension of the manifold of solutions changes)

Analytic solvability excludes the possibility of turning points

Standard Canonical Form, SCF:

$$\begin{bmatrix} I & 0 \\ 0 & N(t) \end{bmatrix} \begin{bmatrix} y_1'(t) \\ y_2'(t) \end{bmatrix} + \begin{bmatrix} C(t) & 0 \\ 0 & I \end{bmatrix} \begin{bmatrix} y_1(t) \\ y_2(t) \end{bmatrix} = \begin{bmatrix} f_1(t) \\ f_2(t) \end{bmatrix}$$

$N(t)$ is nilpotent and upper (or lower) triangular

Strong SCF (SSCF): N is constant

Relation Solvability – SCF:
[Campbell-Petzold]

If A and B are analytic on $I=[0,T]$ then the singular system (1) is analytically solvable

$\Longleftrightarrow$

Transformations of the form

$$\begin{cases} x = Q(t)\,y & \text{(change of variables)} \\ \text{premultiplication by } P(t) \end{cases}$$

(where P, Q are analytic) transform (1) to SCF everywhere on I.

Index of a linear system: $\nu(t)$

Local index: index at a fixed time t_0

$$\nu(t_0) = \mathrm{Ind}(A(t_0), B(t_0))$$

$$P_0 A(t_0) Q_0 = \begin{bmatrix} I & 0 \\ 0 & N_0 \end{bmatrix} \qquad P_0 B(t_0) Q_0 = \begin{bmatrix} C_0 & 0 \\ 0 & I \end{bmatrix}$$

(1) transformable to SCF:

$\nu(t)$ = degree of nilpotency of $N(t)$ (integer)

$$N(t)^{\nu-1} \neq 0 \;, \quad N(t)^{\nu} = 0$$

Fixed index ν system: local index is the same for all t ($\nu(t) = \nu \quad \forall \; t \in I$)

Higher index systems: $\nu(t) \geq 2$

Ex) $$N(t) = \begin{bmatrix} 0 & t & 0 & 0 \\ & 0 & 1-t & 0 \\ 0 & & 0 & 1-t \\ & & & 0 \end{bmatrix} \qquad \nu(t) = 4 \quad t \neq 0, 1$$

$$N(0) = \left[\begin{array}{c|c|c|c} 0 & 1 & 0 & 0 \\ \hline & 0 & 1 & 0 \\ \hline & & 0 & 1 \\ \hline & & & 0 \end{array}\right] \qquad \nu(0) = 3$$

$$N(1) = \left[\begin{array}{c|c|c|c} 0 & 1 & 0 & 0 \\ \hline & 0 & 0 & 0 \\ \hline & & 0 & 0 \\ \hline & & & 0 \end{array}\right] \qquad \nu(1) = 2$$

$[\nu(t) \leq \dim N(t)]$

$$P(t)\,A(t)\,Q(t) = \begin{bmatrix} I & 0 \\ 0 & N(t) \end{bmatrix}$$

$$P(t)A(t)\,Q'(t) + P(t)\,B(t)\,Q(t) = \begin{bmatrix} C(t) & 0 \\ 0 & I \end{bmatrix}$$

Note: If Q constant then $Q'(t) \equiv 0$

Safe transformations:

$x = Q\,y$, $P(t)$ from left

Do not change the index of (1) !

General $P(t)$, $Q(t)$ may change the index of (1) (examples !)

[e.g. Gear-Petzold]

GÖRA PROTOTYP

1. Vem för den vidare?
   Svenskt företag? Vilket?
   Samarbete med utländskt företag?
2. Vad innebär det?
   Bygga verktyg som kan användas internt
   Bygga in extern programvara
3. Resultatet:
   Idéer, rapporter
   Programsystem som kan byggas vidare
   Kunskapsbaser

GÖR DJUPDYKNING PÅ DELPROBLEM

Idéinriktat

Expertsystemsnitt

Systemidentifiering

Supersimulator

Animering

REN PRODUKTUTVECKLING

Simnon II, Idpac II
Stark specialisering
Ambitionsnivå
"Software engineering"
Marknadsföring, underhåll
Policy för programvara
Isolering
Konkurrens

STARKARE KOPPLING TILL ENGELSKA PROJEKTET

Vad gör de?
Vad blir deras policy?
Vad skulle vi kunna bidra med?

INSKAFFA EN MILJÖ, JOBBA VIDARE

Frys en miljö (t.ex EAGLES)
Skaffa in källkod och jobba vidare
Produktinriktat

STYRELSEN FÖR TEKNISK UTVECKLING
SWEDISH NATIONAL BOARD FOR TECHNICAL DEVELOPMENT 1986-12-29
Arne Otteblad/ksb

PROTOKOLL

från möte med STUs styrgrupp för ramprogram CACE den 27/11 1986 kl 9,00 - 16,15 vid Institutionen för reglerteknik, Lunds tekniska högskola.

Närvarande: Styrgruppsmedlemmar:

Sven Gunnar Edlund
Karl Eklund
Gustaf Söderlind
Karl Johan Åström
Arne Otteblad
Eric Sandewall (per telefon)

Projektengagerade:

Sven Erik Mattsson
Gustaf Olsson
Bo Kågström
Dag Brück
Karl-Erik Årzén
Jan-Erik Larsson
Per Persson
Tomas Schönthal

§ 1 Följande formaliteter avklarades inledningsvis:

Ordförande för mötet: Sven Gunnar Edlund
Sekreterare: Arne Otteblad
Justeringsman: Sven Erik Mattsson

Den föreslagna dagordningen godkändes.

Föregående protokoll godkändes.

§ 2 Genomgången av föregående protokoll medförde följande uppdateringar rörande framtida projektgrupps- och styrgruppsaktiviteter:

a/ Mötet mellan CACE-gruppen och Eric Sandewalls grupp planeras bli i januari.

b/ Informationsseminariet med projektpresentationer och diskussion av den framtida verksamheten planeras gå av stapeln i mars -87. 50-150 personer bör inbjudas till seminariet, som lämpligen förläggs till Stockholm (STUs hörsal). Karl Johan Åström och Sven Erik Mattsson utarbetar ett preliminärt program, som sedan diskuteras vid telefonmöte den 7 januari kl 13,00

c/ Före seminariet i mars bör projektgruppen genomföra arbetsmöten med de viktigaste användarna av CACE-programmen. En möjlig lösning är att genomföra två en-veckors-turnéer till de stora användarföretagen.

§ 3 En översiktlig presentation av läget inom de olika delprojekten gjordes. Kopior av overhead-bilderna utdelades till deltagarna.

Speciellt kan nämnas att John Baras från Systems Research Center vid University of Maryland kommer att besöka Karl Johan Åström den 15 december för diskussion av framtida forskningssamarbete. Vidare nämndes att ett nytt möte med verksamma inom SERC-programmet planeras hållas i mars-april. Man skall då diskutera expertsystemsidan.

Upphandlingen av den LISP-arbetsstation, som institutionen fick medel till ur FRN-ramen, går planenligt. Offerterna är nu på väg till Utrustningsnämnden.

§ 4 Jan-Erik Larsson och Per Persson presenterade projektet "Experiment med expertsysteminterface" och demonstrerade vissa funktioner.

§ 5 Bo Kågström presenterade arbetet inom projektet "Numerisk behandling av differentialalgebraiska system"

§ 6 Vi har nu kommit ungefär halvvägs i CACE-programmet. Detta var utgångspunkten för en intensiv diskussion av det framtida arbetets uppläggning. Olika möjligheter från ren produktutveckling till djupdykande forskning diskuterades. Som exempel på hur krävande produktutvecklingen är, belyste Tomas Schönthal den arbetsinsats på uppemot 1 1/2 manår som PC-versionen av SIMNON tagit i anspråk.

Diskussionerna visade att det var en allmän uppfattning att man måste göra djupdykningar på vissa delproblem, men också att man inom institutionen måste ta fram fullskaleprototyper, som är så tillrättalagda att industrin kan ta hand om dem och utveckla dem till kommersiella produkter. En väg kan vara att sprida CACE-verktygen genom att paketera dem i andra produkter. DUP-programmet kan också ge vissa spridningsmöjligheter.

Karl Johan Åström och Sven Erik Mattsson utarbetar ett förslag till framtidsplan, som får diskuteras vid ett framtida telefonmöte.

§ 7 Mötet avslutades med ett antal demonstrationer vid den grafiska arbetsstationen IRIS 2400.

Vid protokollet

Arne Otteblad
STU

Justeras
Sven Erik Mattsson
Sven Erik Mattsson
LTH