The CACE Project -- Steering Committe Meeting 1987-11-25

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The CACE Project - Steering Committee Meeting, 1987-11-25

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Abstract

This report contains documentation handed out to the participants of the steering committee meeting of the STU Computer Aided Control Engineering Programme (CACE) on November 25, 1987. The minutes of the meeting are also included.

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Preface

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- Struktureringsbegrepp
- Representation
- Tillämpningsprojekt

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13.45 **Information om DUP och IT**

14.15 **Framtida planer – efter CACE**

14.45 **Nästa sammanträde, övrigt**

15.00 **Demonstrationer**
- G2
- Modellverktyg
- Expert Control (min 30 min)
- Examensarbete "Visidyn"

17.00 **Avslutning**

PROJECT STATUS

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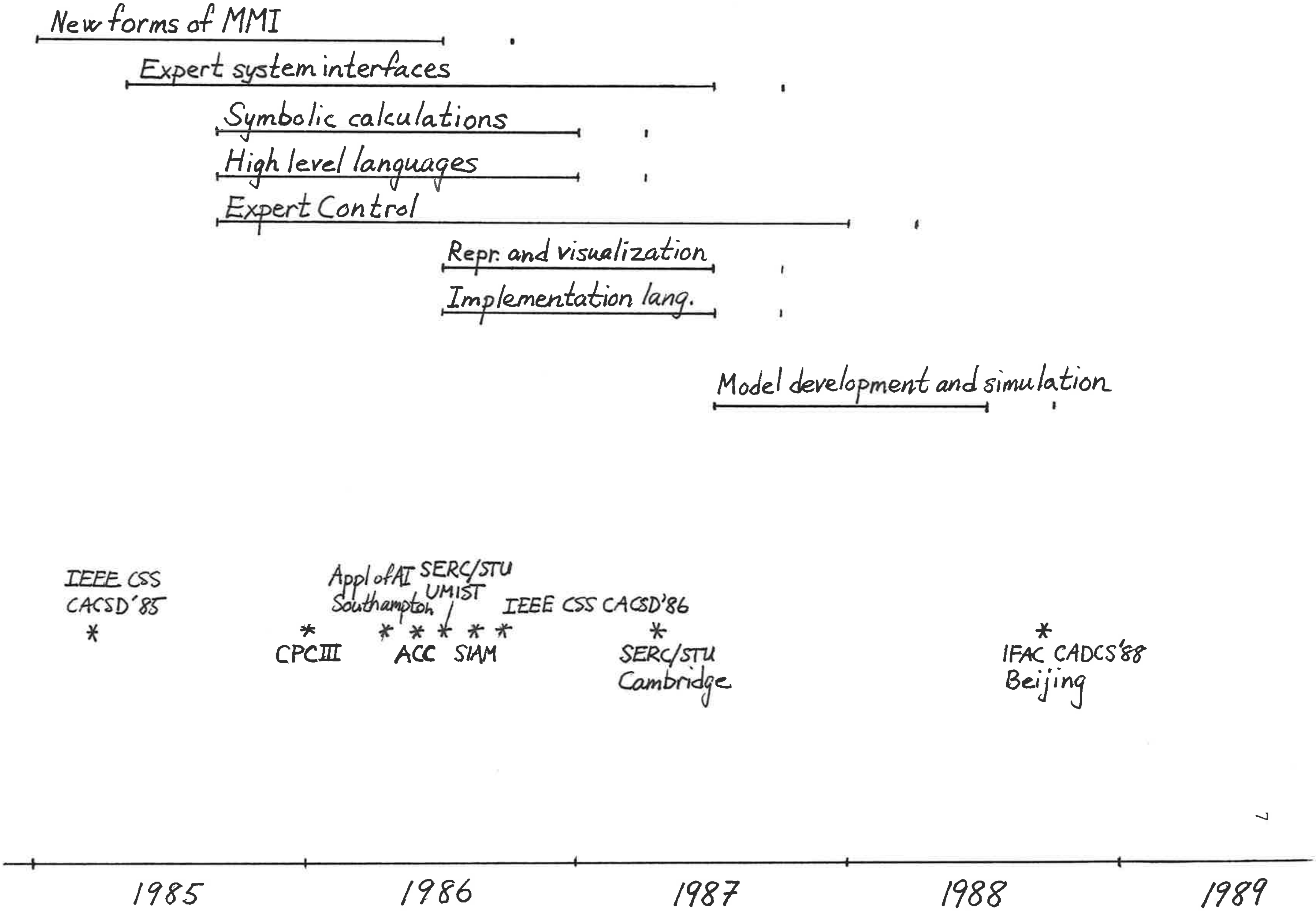
New forms of MMI
Expert system interfaces
Symbolic calculations
High level languages
Expert Control
Repr. and visualization
Implementation lang.
Model development and simulation
IEEE CSS CACSD'85
CPCIII
Appl of AI Southampton
ACC
SERC/STU UMIST
SIAM
IEEE CSS CACSD'86
SERC/STU Cambridge
IFAC CADCS'88 Beijing
1985
1986
1987
1988
1989

WORKSTATION PURCHASES

1. Symbolics 3650
   - Mono, 19", 8MB, FP acc.
   - 330 MB Winchester
   - Fortran, Pascal, Common Lisp Prolog
   - Macsyma, KEE, G2
   - Delivered in May 1987
   - FRN financed
2. SUN 3/110
   - Color, 19", 4MB
   - 12 MB memory (Clearpoint, Exo Data AB)
   - KEE
   - 140 MB local Winchester disk
   - 538 MB common Winchester disk
   - Delivery scheduled to Nov 1987
   - STU financed

GUEST RESEARCHERS

1985, Nov 18 – 1986, Jan 17	Dr. Wolgang Kreutzer Univ. of Canterbury New Zealand
1986, Nov 6 – Dec 8	Prof. Mike Denham Kingston Polytechnic England
1987, May 17 – July 17	Prof. Dean Frederick RPI, Troy New York, USA
1987, Dec 1 – 1988, Jan 31	Dr. Wolgang Kreutzer Univ. of Canterbury New Zealand
1988, May – June	Prof. Doug Birdwell Univ. of Tennessee Knoxville, Tennessee

TOOLS FOR MODEL DEVELOPMENT AND SIMULATION

Plan

1. Design of basic concepts for model structuring
2. Design of the internal system representation
3. Implementation in KEE of basic tools for modelling and simulation of ODE models
4. Extension of the tools in various directions
   - User interface
   - Frameworks to describe behaviour
   - Analysis tools
5. C++ and PHIGS (FIGARO)
6. Applications

C++

C++ is a superset of the C language and was designed to

1. be a better C
2. support data abstraction
3. support object-oriented programming.

C++ is available from AT&T.

PHIGS

Programmers Hierarchical Interactive Graphics Stand.

- ANSI Standard
- Designed for complex interactive applications
  CAD, CAM, CAE, Robotics, Architecture
- Full 3-D system
- Structured organization of graphics
  in a centralized database
- IBM: graPHIGS
- Template: FIGARO
- Windowing systems???

Seminars and Visits

December 1986 – November 1987

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 December 1986 – November 1987, 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.

1986

Dec 4	Karl-Erik Årzén visited Domain Computers in Kista to look at the Apollo DN 580 workstation.
Dec 15	John Baras, which is the initiator and leader of the Systems Research Center at the University of Maryland visited the department. Arne Otteblad, STU gave a short presentation of the new research programme DUP and other STU activities.
Dec 15	Olle Lennartsson, Texas Instruments visited the department to discuss the Texas Explorer Lisp machine.
Dec 17	Bengt Bengtsson, Department of Telecommunication, LTH gave a seminar and presented DSP-90, which is a general purpose system for digital signal processing based an a TMS 32010. Our department has purchased such system.
Dec 17	Mats Lilja, Kjell Gustafsson and Bengt Mårtensson gave a seminar on GNU Emacs, which is a powerful editor. It is available on BODE, and some other Vax'es at the university. The seminar presented GNU Emacs from a conceptual point of view. In particular, a ReglerTEX-mode was presented.
Dec 18	Christer Sjöberg and Jan Ekman from Nokia visited the department to discuss the Symbolics Lisp machine.

1987

Jan 15	Karl-Erik Årzén and Per Persson visited Nokia in Stockholm. The new Symbolics operating system was demonstrated.
Jan 16	Leif Persson, Ann-Britt Östberg, Erik Larsson, Peter Engström and Dan Nordström from Sydkraft, Malmö visited the department. We found that we have common interests in modelling and simulation. It was decided that Leif Persson and Ann-Britt Östberg should accompany us on our trip to the Central Electric Generating Board (CEGB), Gloucester, England on February 9 – 11, 1987.
Jan 22	Sven Erik Mattsson visited the Department of Automatic Control, LiTH, Linköping. He gave a seminar titled "On Differential/Algebraic Systems."
Jan 23	Börje Rosenberg, SattControl, Lund visited the department.
Jan 27 – 30	Karl Johan Åström, was a member in a delegation, which went to Apple in Cupertino to discuss a donation from Apple to the University of Lund.
Feb 2	Sven Erik Mattsson, Lars Nielsen, Karl-Erik Årzén, Jan Eric Larsson, Per Persson, Ola Dahl and Kjell Gustafsson visited the Department of Computer and Information Science, LiTH, Linköping. Erik Sandewall and Sture Hägglund presented their research projects. Sven Gunnar Edlund, STFI, Arne Otteblad, STU and Gustaf Söderlind, LTH which are members of the CACE Steering Committee participated also.
Feb 5 – 6	Sven Erik Mattsson, Dag Brück and Tomas Schönthal visited the University College of Swansea, Swansea, Wales. Hosts were Professor Tony Barker, Department of Electrical and

Electronic Engineering and Dr Peter Townsend, Department of Mathematics and Computer Science.

The departments of Electrical and Electronic Engineering and Mathematics and Computer Science, University College Swansea participate in the SERC Programme of research in Computing and Design Techniques for Control Engineering (CDTCE).

We have common interests in man-machine interfaces and in this area it is of special importance to be able to exchange ideas and experience. They also expressed an interest to collaborate. As a first step they got Simnon and Idpac. An exception handling package for C was sent later. We got CES and examples of how to use SUN's window and menu facilities from inside a program. This will facilitate our work.

They were very interested to use Simnon in their education and as the simulation tool in CES. The discussion on the user interface gave us good inputs for the next version of Simnon. Other common interests, which we were not aware of before the visit, are symbolic manipulation and MACSYMA.

Feb 9 – 11 Karl Johan Åström, Sven Erik Mattsson, Dag Brück, Tomas Schönthal from the Department of Automatic Control, Lund Institute of Technology, Lund, Sweden and Leif Persson and Ann-Britt Östberg from Sydkraft, Malmö, Sweden visited the Central Electricity Generating Board (CEGB), Barnwood, Gloucester, England. CEGB corresponds to Vattenfall in Sweden.

The visit was organized and planned by Mr M.J. Whitmarsh-Everiss who is head of the Plant Kinetics Group, Boiler Plant Branch, Plant Engineering Department, Generation Development & Construction Division in Barnwood, Gloucester. The aim was to exchange information and discuss various issues in computer aided control engineering and modelling of power plants. CEGB has a long experience in designing and using programs for computer aided engineering. Very elaborate simulation of power system components is a speciality; 500–4000 states is a typical size range. To be able to do that, good, fast and robust numerical routines for integrating large systems of stiff equations have been developed.

A collaboration between the CACE project at the Department of Automatic Control, Lund Institute of Technology and the groups under Whitmarsh-Everiss and Dick Adams at Barnwood and Trevor Chambers at Park Street, London would be of mutual benefit. We have many common areas of interest as CACE methodology, numerics and modelling.

Feb 11 Karl Johan Åström was invited to travel with Whitmarsh-Everiss and a CEGB delegation to Marconi Simulation in Edinburgh. Marconi has a long experience in developing simulators for military and civil purposes. They have developed the plant simulators for the nuclear power plants Hunterston B and Torness for SSEB (South Scotland Electricity Board).

The Torness simulator was at the Marconi plant for final testing. The simulators were quite complicated having more than 10 000 states. The simulators were based on special purpose parallel hardware. The Mk IV system for Hunterston B had 52 microprocessors, two were allocated to the axial reactor model, 10 for the two-dimensional reactor model, and 18 for the boiler model.

Feb 11 — Karl-Erik Årzén participated in Svenska Mekanförbundet's steering committee meeting on Knowledge Based Systems at Volvo Data in Gothenburg.

Feb 12 — A group of four persons from Rifa and Ericsson, Kista visited the department.

Feb 18 — Mats Andersson attended a half-day seminar and demonstration of KEE at Nokia in Stockholm.

Feb 18 — Per Persson attended a seminar held at Saltsjöbaden presenting Alliant Computer Systems' products.

Feb 18 – 19 — Karl Johan Åström, Gustaf Olsson, Sven Erik Mattsson, Per Persson and Tomas Schönthal visited the Swedish Pulp and Paper Research Institute (STFI), Stockholm. Sven Gunnar Edlund and his colleagues Vikram Kaul, Jan Erik Gustafsson and Thomas Östman presented STFI and their research. Sven Erik Mattsson gave an overview of the CACE project and presented Hibliz. Per Persson presented his and Jan Eric Larsson's work on expert system interface for Idpac. STFI are experienced users of Idpac and Simnon. They have interesting suggestions on extensions of Idpac. As a start we formulated some new Master Thesis projects.

Feb 24 — Torbjörn Sjöö, Silicon Graphics AB visited the department. Silicon Graphics has opened an office in Bromma, Sweden.

Feb 25 — Torbjörn Johansson, IBM, Stockholm gave a full day seminar on the IBM PC RT and ANDREW. ANDREW is a distributed personal computing environment based on UNIX BSD 4.2. It is a collaborative between IBM and Carnegie-Mellon University.

Feb 26 — Anders Åberg, ASEA Research & Innovation, Västerås visited the department. He gave an informal seminar on ASEA's activities in the expert system area.

March 6 — Karl-Erik Årzén participated in a ESGIL (Expert Systems Group In Lund) meeting at Telelogic in Malmö.

March 11 — Eric Astor, Department of Computer Science and Computer Engineering, LTH gave a seminar on the expert system developing environment KEE. KEE will be available on our new Symbolics workstation.

March 12 — Klas Rytoft and Lars Richter, ASEA Research & Innovation, Ideon, Lund visited the department.

March 17 — Karl Johan Åström, Sven Erik Mattsson, Karl-Erik Årzén, Per Persson, Jan Eric Larsson and Mats Andersson visited the Swedish Institute of Computer Science, SICS in Kista. Rune Gustavsson gave an overview of SICS. SICS constitutes of three laboratories: Design Methods (Björn Pehrsson), Logic Programming Systems (S. Haribi) and Knowledge-Based System (Rune Gustavsson). The Design Method Laboratory works on computer communication and graphics. Steffen Weckner presented their work in the graphics area. They have developed a system called Dialogie for interactive programming using pictures and text. It is implemented in Loops on Xerox Interlisp machines. The Logic Programming Systems Laboratory works on (parallel) computer architectures and extensions to Prolog. The Knowledge-Based Systems Laboratory works on theory, natural languages, and empirical research. Their applications are large databases and dynamical systems.

SICS is financed to 50% by STU and to 50% by Ericsson, Philips, ASEA, IBM and Televerket. The budget is 24 MSEK. Each laboratory has about 15 persons.

March 18 — Bengt Mårtensson gave a seminar about some programs for document preparation (TEX, PostScript, Emacs) and support and interface programs (DVILW, HCOPY2PS, CC2PS, MACEQ2TEX, S2TEX, CODEGEN, MIMNON, FUSION, GNUPLOT, LESS, DVITT).

March 20 — Jan Eric Larsson and Per Persson presented their Lic Techn thesis "An expert system interface for Idpac." Opponents were Rune Gustavsson, SICS, Stockholm and Ivar Gustavsson, ASEA Generation, Ideon, Lund.

Rune Gustavsson gave in the afternoon a seminar titled "AI and expert systems."

March 25 — Arranged together with the Swedish National Board for Technical Development (STU) a full day-seminar in Stockholm. The purpose was to present results and experiences from the CACE project; Karl Johan Åström: "Computer aided control design – A perspective," Jan-Erik Gustafsson, STFI, Thomas Östman, STFI and Claes Källström, SSPA: "Experiences of using Simnon and Idpac," Sven Erik Mattsson: "The CACE project – An overview" and "Hibliz – A simulator using hierarchical block diagrams," Jan Eric Larsson and Per Persson: "Expert System Interfaces," Ulf Holmberg: "Symbolic Formula Manipulation," Karl-Erik Årzén: "Expert Control" and Arne Otteblad, STU "Related STU projects." About 50 persons from university and industry attended the seminar.

April 1 — Lars Richter, ASEA, Ideon presented Asea Master in the undergraduate course "Computers in Control Systems".

April 8 — Hilding Elmqvist, SattControl presented SattGraph 1000 in the undergraduate course "Computers in Control Systems".

April 6 – 10 — Karl Johan Åström, Karl-Erik Årzén and Per Persson participated in the Joint SERC/STU Workshop on Expert Systems and Data Bases for Control System Design and Application held at Cambridge, UK. The presentations given were:
Karl-Erik Årzén: "Knowledge based controllers"
Karl Johan Åström: "Expert control methods for assessment

	of achievable control performance" Per Persson: "An expert system interface for Idpac" The workshop was organized by Professor MacFarlane and contained several demonstrations. An overview of the current status of the ECSTASY was given.
May 11 – 13	Professor Neil Munro, Dr John Edmunds and Gavin Bowe, UMIST, Manchester, UK visited the department. On May 12 Prof Munro gave a seminar on ECSTASY and Dr Edmunds presented CSS (The Control System Software).
May 14	Anders Törne and Martin Uneram, ASEA visited the department. They are members of Anders Åberg's AI-group. They gave a seminar titled "Robot programming."
May 17	Professor Dean Frederick, Rensselaer Polytechnic Institute, Troy, New York, USA arrived. He participated as a guest researcher in the CACE project for two month (May 17 – July 17). He developed together with Tomas Schönthal a prototype window-based environment for Simnon on the SUN workstation.
May 18	Jan Eric Larsson and Per Persson participated in the SAIS'87, The Swedish AI Society's Annual Workshop, Uppsala. They presented "An intelligent help system for Idpac."
May 21	Lars Rundqwist presented and demonstrated the new lab 4 of the course "Computers in control systems." The lab task is level control of a water tanks and sequence control of a tee kettle. The ASEA MasterPiece system is used. The program MasterAid 120 running on a IBM-PC is used to program the ASEA MasterPiece. For MMC the PC-Operator program also running on the IBM-PC is used. It is developed by Rejlers Ingenjörsbyrå, Lund. It uses semigraphics and the MicroSoft Mouse. It can communicate with a number of commercial control systems among others those from Asea (Master), SattControl and Saab (PCC). The real-time aspects is handled by TopView, a IBM program.
May 26	Rod Bell, Macquarie University, Australia gave a seminar titled "Boiler turbine modelling and simulation."
May 27	Dean Frederick, Rensselaer Polytechnic Institute, USA gave a seminar titled "Windowing for Simnon."
June 2 – 4	Mats Andersson attended the IMACS-International Symposium on AI, Expert Systems and Languages in Modelling and Simulation, Barcelona, Spain, 2 – 4 June 1987.
June 9 – 10	J.T. Tanttu and M. Aaltonen, Department of Electrical Engineering and Control Engineering, Tampere University of Technology, Finland visited the department. They have designed and implemented MAX, which is an interpreted language for polynomial matrix manipulations. It contains especially operations frequently needed in the analysis of linear control systems. MAX is written in C under VAX/VMS.
June 15	Karl Johan Åström and Sven Erik Mattsson together with Clas Rytoft, Asea, Ideon visited Jens Rasmussen, Risø National Laboratory, Roskilde, Denmark to discuss MMI.

June 18	Mats Andersson gave a seminar titled "Impressions from the IMACS symposium in Barcelona on modelling and expert systems."
June 22 – 30	Mats Andersson attended a course on KEE Software Development System arranged by Intellicorp in Munich, Germany. We have KEE on our Symbolics machine.
June 26	Karl Johan Åström, Sven Erik Mattsson, Jan Eric Larsson and Per Persson visited Professor Morten Lind, Servolaboratoriet, The Technical University of Denmark, Lyngby, Denmark. Professor Lind got his chair recently. He presented his plans, which are oriented towards use of AI techniques for control, supervision and operator support. We also have common interests in how concepts for system descriptions should look like. He has invented a multilevel flow modelling language.
July 2	Dean Frederick, RPI, gave a seminar titled "Benchmark problems for CACSD." For further information see M. Rimer and D. Frederick: "Solutions of the Grumman F-14 Benchmark Control Problem", IEEE Control Systems Magazine, Vol. 7, No. 4, August 1987, pp. 36–40.
July 7	Per Olof Gutman, Electro Optical Ind, Israel gave a seminar titled "Horowitz' design method in the general SISO case" and gave a demonstration of Horpac.
July 14	Dr Bijoy. Gosh, Washington University, USA, gave a seminar titled "AI methods in robust stabilization of time-varying systems."
July 16	Dean Frederick, RPI presented and demonstrated an experimental window-version of Simnon running on the SUN system.
July 27 – 31	A group from the department attended the 10th IFAC World Congress on Automatic Control, Munich, Germany. Sven Erik Mattsson and Mats Andersson participated in the meeting of the IFAC Working Group on "Guidelines for CACSD Software".
Aug 6 – 7	Odd Andreas Asbjoernsen, University of Maryland, USA, David Prett and Carlos Garcia, Shell Development Company, Houston visited the department. Professor Asbjoernsen gave a seminar titled "A system approach to modelling", Dr Prett talked about computing in manufacturing and Dr Garcia gave a seminar on "Design of robust controllers."
Aug 13	Professor Morten Lind, Servolaboratoriet, The Technical University of Denmark, Lyngby, Denmark and some from his group visited the department to learn about our projects.
Aug 24	Karl-Erik Årzén visited UPMAIL in Uppsala to listen to a presentation of the G2 real-time expert system framework by Robert Moore, Gensym Corp.
Aug 26	Lars Rundqwist gave a seminar on how to use MacDraft figures in TeX.
Aug 27	Jonas Fredenholm presented his MSc project "Primitive adaptive robot programs. Supervisor was Jan Eric Larsson.

Sept 4	Some of the members of the CACE group gave a two hours' information seminar for the department: Sven Erik Mattsson: "CACE experiences", Bernt Nilsson: "Experiences of some modelling languages", Mats Andersson: "Object oriented system representation" and Sven Erik Mattsson: "Plans for the CACE project."
Sept 11	Graphics standards is a difficult issue. The ISO standard GKS is of too low level (just 2D, non-hierarchical) and good implementations. However, a new ANSI standard, PHIGS (Programmers Hierarchical Interactive Graphics Standards) seems to be promising. It is supported by IBM. To get experiences of PHIGS an implementation called FIGARO from TEMPLATE Software Division of Megatek Corporation, San Diego, CA, USA for use on our IRIS 2400 was ordered. However, it turned out that TEMPLETE could not ship this version in time. So it was agreed that we should get a version running on the IRIS for Tektronix terminals. This version was installed by Max L. Elliott, GTS-GRAL, Darmstadt, Germany. He has been involved at the development of FIGARO. He gave a seminar titled "Overview of PHIGS, PHIGS vs. GKS and other common standards, FIGARO on the IRIS 2400." The real IRIS version of FIGARO was scheduled to the end of October 1987.
Sept 18	Bo Månsson, Corporate Technical Co-ordination Department, Asea paid a visit. He developed SYMBOL 4000 which is a program for drawing electrical circuits.
Sept 21	Sven Erik Mattsson, Karl-Erik Årzén, Jan Eric Larsson, Per Persson and Mats Andersson visited Professor Morten Lind and his group, at Servolaboratoriet, The Technical University of Denmark, Lyngby, Denmark. We discussed the possibilities of having joint projects. We also went to Søren T. Lyngsø to get a demonstration of STELLA AI, TOR and ODIN, which are commercial AI and expert system tools oriented towards real time application from the Expert System Builder (ESB) Esprit project. They are written in Common Lisp and runs on Symbolics machines, Texas Explorer and SUN workstations. These tools are of interest for us.
Oct 2	Sven Erik Mattsson accompanied Arne Otteblad, Evy Jacobsson, Tomas Liljemark, Leif Maartman, Göran Olsson, STU on their visit to Studsvik to present the DUP project and to discuss MMI and simulation. Host was Håkan Andersson.
Oct 9	Professor David Powell, Stanford visited the department.
Oct 13	Bengt Mårtensson gave a seminar on "Hcopy2PS, curve compression and some other programs."
Oct 14	We have got a copy of Matrix-X for VAX-stations. Mats Lilja gave a demonstration focussing on SYSTEM_BUILD and the graphics.
Oct 17	Dr Robert Moore visited the department. He is the director of Gensym Corp. who has developed the real-time expert

system framework G2 which we recently have got for the Symbolics. G2 is aimed at process monitoring applications and is a successor of the PICON system from LMI. Bob gave a talk about the system and demonstrated it.

Oct 19 – 21	Karl-Erik Årzén participated in the First European Meeting on Cognitive Science Approaches to Process Control in Marcoussis, France. The meeting mainly concerned the role of the process operators from different viewpoints. Valuable contacts were established with Gunnar Johannsen's group in Kassel, W. Germany who work in a Esprit project on expert systems for process monitoring and intelligent tools for user-interface design.
Oct 29 – 30	Karl-Erik Årzén participated in an AI symposium arranged by the Erik Philip Sörenssen Stiftelse. The participants were all from departments at Lund University.
Oct 30	Information seminars at the department: Mats Lilja, "Controller design based on frequency responses," Bo Bernhardsson, "A dual controller" and Kjell Gustafsson and Michael Lundh, " PI-control of the stepsize in numerical integration."
Nov 3	Professor Makoto Nagao, Kyoto University, Japan visited the department. He gave a seminar titled "Image processing and character recognition." It was a part of the formal exchange program between Kyoto University and Lund University. Professor Nagao visited a number of department during the week in Lund.
Nov 5 – 6	In connection with Karl-Erik Årzén's dissertation the department was visited by the opponent Dr. Roy Leitch, Heriot-Watt University, Edingburgh, UK and the committee members Anders Åberg, ASEA, Västerås, professor Morten Lind, DTH, Lyngby, Denmark and professor Chris Harris, University of Southampton, UK Dr Leitch has participated in Alvey and Esprit projects on expert systems for control. Dr Harris is "Lucas Professor of Aerospace Systems Engineering" and has earlier been at the Royal Military College, Swindon.
Nov 5	Karl-Erik Årzén presented and demonstrated G2, which is an expert system shell for process control from Gensym Corp. Dr. Harris gave a seminar titled "Autonomous vehicle control using knowledge based fuzzy logic" and Dr. Leitch gave a seminar on "Qualitative modelling in industrial control."
Nov 6	Karl-Erik Årzén defended his Ph.D-thesis "Realization of Expert System Based Feedback Control." Dr. Harris gave in the afternoon a tutorial on "Multi-sensor data fusion - use of Dempster Schafer theory - reducing uncertainty."
Nov 13	Björn Tyreus, DuPont, USA visisted the department. His interests include modelling and control of chemical processes. He experiments with G2. He gave a seminar on control structures.

The CACE Project 1987-11-23
Department of Automatic Control
Lund Institute of Technology, Lund, Sweden

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How Could Future CACE-systems Look Like?

Not closed packages

Must be extensible

Tools, toolbox, toolmachine
  modularized with well-defined interfaces
  integrated; uniform interface for a user

Modularization:

1. User interface
2. Data
3. Processing tools

THE USER INTERFACE

1. Various types of I/O devices:
   - Keyboard
   - Light pen, mouse
   - Voice
   - Alphanumeric display
   - Graphics display (mono, color)
2. Different users have different needs
   - Command dialogue
   - Menus (Pop up, pull down etc.)
   - Graphics
   - Macintosh, Smalltalk 80, Lisp environments
   - Help systems
   - Expert system interfaces

$$\Longrightarrow$$

Separate the user interface from processing tools.

Could view the CACE-system as performing a Read-Evaluate-Print loop

The user interface should handle all communication with the user:

1. Collect the user input
   Prompt when needed
   Expert system interfaces
2. Convert to a textual representation
   Logging, command procedure
3. Invoke a processing tool
4. Present results and errors messages to the user or the command procedure!

User interface: Language and environment
The objects and operations should have same semantics
but different syntax: Text, menus, graphics.

DATA

Should be common to make the tools integrated.

All information must be available for

1. The User
2. Expert system interfaces
3. Command procedures

Models etc on symbolic form from which linearized models code for simulation etc could be generated.

PROCESSING TOOLS

Must not communicate with the user.

Should not have internal states.

Could provide test functions, so the user interface could check arguments before invoking a tool.

THE PRINCIPLE OF REUSE

Model development can be supported by making it easier to reuse models in various contexts.

1. Models on symbolic forms
   from which the CACE system can generate
   - efficient code for simulation
   - code for calculation of steady state
   - linear models etc.
   - descriptions accepted by other packages
   - control code
2. Model structuring concepts:
   - Hierarchical submodel decomposition
   - Model types
   - Multiple realizations
   - Model categorization
   - Multiple presentations
3. Parameterization of models

THE SUBMODEL CONCEPT

1. Possible to map the component structure of real systems
   - Common base
   - Supplier provided models
2. Encapsulated models with well-defined interfaces
   - Terminals
   - Parameters
3. No nesting of model type definitions
4. No visibility from inside
   - No global variables, except time
5. Restricted visibility from outside
   - Modelling of interaction; terminals
   - Inspection, plotting
   - Parameterization

A model consists of three parts:

1. Terminals
2. Parameters
3. Realization

THE REALIZATION PART

Structured models

1. Composite models
   - Interconnected submodels
2. Primitive models
   - Support various frameworks
   - Declarative models – Equations, relations

MULTIPLE REALIZATIONS

A model can have multiple realizations:

1. Realizations of different complexity
   - Retaining of old versions for comparison
   - Inclusion and exclusion of various features
   - Impossible to make the "complete" model

     Normal operation – malfunctions
2. Supports abstract components which can be implemented in various ways

We propose a flat multiple realization concept.

MODELLING OF INTERACTION BETWEEN SUBMODELS

Should be flexible:

- Anticipate "all" ways of interaction
- Avoid the need of adapters and converters

$$\Longrightarrow$$

1. Keep the semantics of connections simple
   - Equality or zero-sum of terminals
   - Facilitates use of block diagrams
   - Submodels can handle complex descriptions
2. Component based models give a common base
   - Possible to anticipate "physical" interactions
   - Hard to anticipate measurements.
   - Idealized models of real "physical" connections as shafts, pipes, electrical wires etc.
   - Build libraries of terminals

TERMINALS

Terminals can be structured

1. Simple
   - A single quantity
2. Record
   - Interaction involves often several quantities
   - May be nested
   - Example: A wire may be described by voltage and current
3. Vector
   - Has components of the same type
   - Example: A cable has of a number of wires
   - Example: A mass flow may be multi media

Terminals may be partly unspecified:

1. The types of the subterminals
2. The number of subterminals

to support

1. Generic models
2. Plug in models
3. Abstraction – Top-down development
4. Automatic declaration – Bottom-up development

MODELLING OF INTERACTION BETWEEN SUBMODELS

Should be safe and reliable:

- The terminals are holes in the wall
- Automatic consistency checks of connections

$$\Longrightarrow$$

Automatic consistency checks of connections

Possible approaches:

1. Structural equivalence of terminal types
   - Too weak;
     Allows connection of voltage to current
2. Name equivalence of terminal types
   - Too rigid;
     Information must be encoded
3. Explicit information – terminal attributes
   - Examples
     - Name of quantity – ISO 31
     - Unit
     - Range of validity
     - Pipe diameter
     - Name of medium
   - A way to propagate parameters

PARAMETERS

Could be used to define

1. Actual realization version
2. The type of a submodel; plug-in models
3. The number of elements of a submodel vector
4. The number of elements of a terminal vector
5. Physical parameters

A parameter valued could be defined by:

1. Default values
2. Explicit setting by the user
3. Setting by the super model;
   hierarchical parameters
4. Deduced from connections

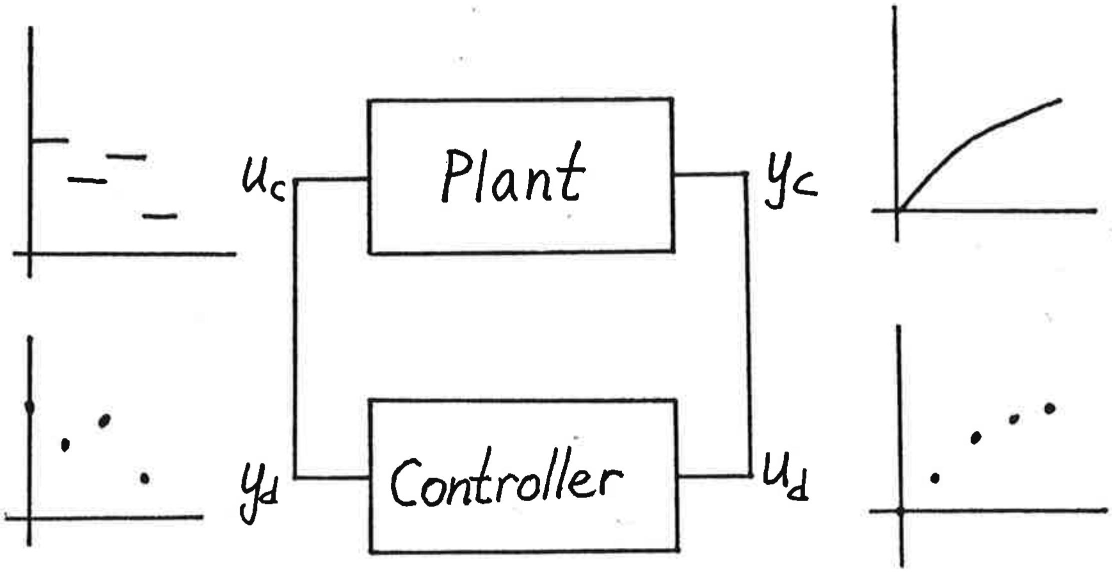
FRAMEWORKS TO DESCRIBE BEHAVIOUR

1. Continuous-system modelling
   - Describes the behaviour at all times
   - ODE's and PDE's
2. Discrete-event modelling
   - Snap-shoots at instants of "interest"
   - Sequence of events and difference equations
3. Qualitative models
   - High level models
   - Incomplete and uncertain information

Motives for combined discrete-continuous modelling:

1. ODE's: Basic in automatic control
2. Difference equations: Digital controllers
3. Discrete events: Idealization of short transients
   Change of realization

WHEN IS A RELATION VALID?



Assume

1. continuous-time plant model
2. digital controller
3. zero-order hold samplers

How should we interpret the connections

1. $u_d = y_c$
2. $u_c = y_d$

$$\Longrightarrow$$

The model developer must specify connections between continuous-time models and discrete models more specificly.

COMBINED MODELS

Only one framework for a primitive model:

1. Enforces structure and avoids messy models
2. The semantics of variables and equations are given implicitly

The model developer must describe the causality of connections between continuous-time models and discrete models.

SAMPLED MODELS – DISCRETE-TIME MODELS

It is desirable to have the same structuring concepts when using difference equations as when using ODE's.

The difficulties are due to different time concepts.

Introduce two discrete submodel types:

1. Discrete-time
   - Primitive models uses difference equations
   - Can be composed of submodels
   - Interactions are described by relations
   - Sampling times are defined at higher levels
2. Sampled
   - Makes it possible to combine frameworks
   - The terminals are either inputs or outputs
   - The encapsulation functions as a sample and hold of the terminals
   - At sampling times the inputs are read and the outputs are calculated
   - Discrete-time submodels are allowed
   - Should submodels of ODE type be allowed?

The unsymmetry due to the introduction of the sampled model type is motivated by:

1. The behaviour of a system between the sampling points is also important
2. The model developer must define the causality of connections between two discrete models having different sampling times
3. The sampled model type makes it easy to achieve synchronous sampling of discrete-time models

DISCRETE EVENT MODELS

Well-established modelling style.

Object-oriented programming – Simula.
Procedural descriptions of behaviour.

Knowledge-based engineering – Expert systems
Rules, declarative descriptions.

Will not discuss general discrete-event modelling, but focus on how ideas can be used in a basically continuous-system modelling style:

1. Idealized models of short transients
   Example: Bouncing ball
2. Change of realization
   Example: Normal operation $\Longrightarrow$ emergency

DISCRETE EVENT MODELS

Properties:

1. Its terminals should be either inputs or outputs
2. Can have internal states
3. Event: zero-crossing from below of an indicator
4. Can wait for one or many events
5. When an event occurs it becomes active
6. Can switch realizations and set states of other models

An Integrated Environment for CACE.

* A unified representation scheme for models
* A coherent user interface
  Graphics, direct manipulation, intelligent help
* Symbolic manipulation
* Simulation tools
* Tools for numeric calculations
* Model libraries
* Process and control knowledge bases

What should be represented?

MODEL STRUCTURE:

Inputs, Outputs, Submodels, Parameters...

BEHAVIOUR DESCRIPTIONS:

Nonlinear equations,
linear statespace descriptions,
transfer functions, qualitative descriptions...

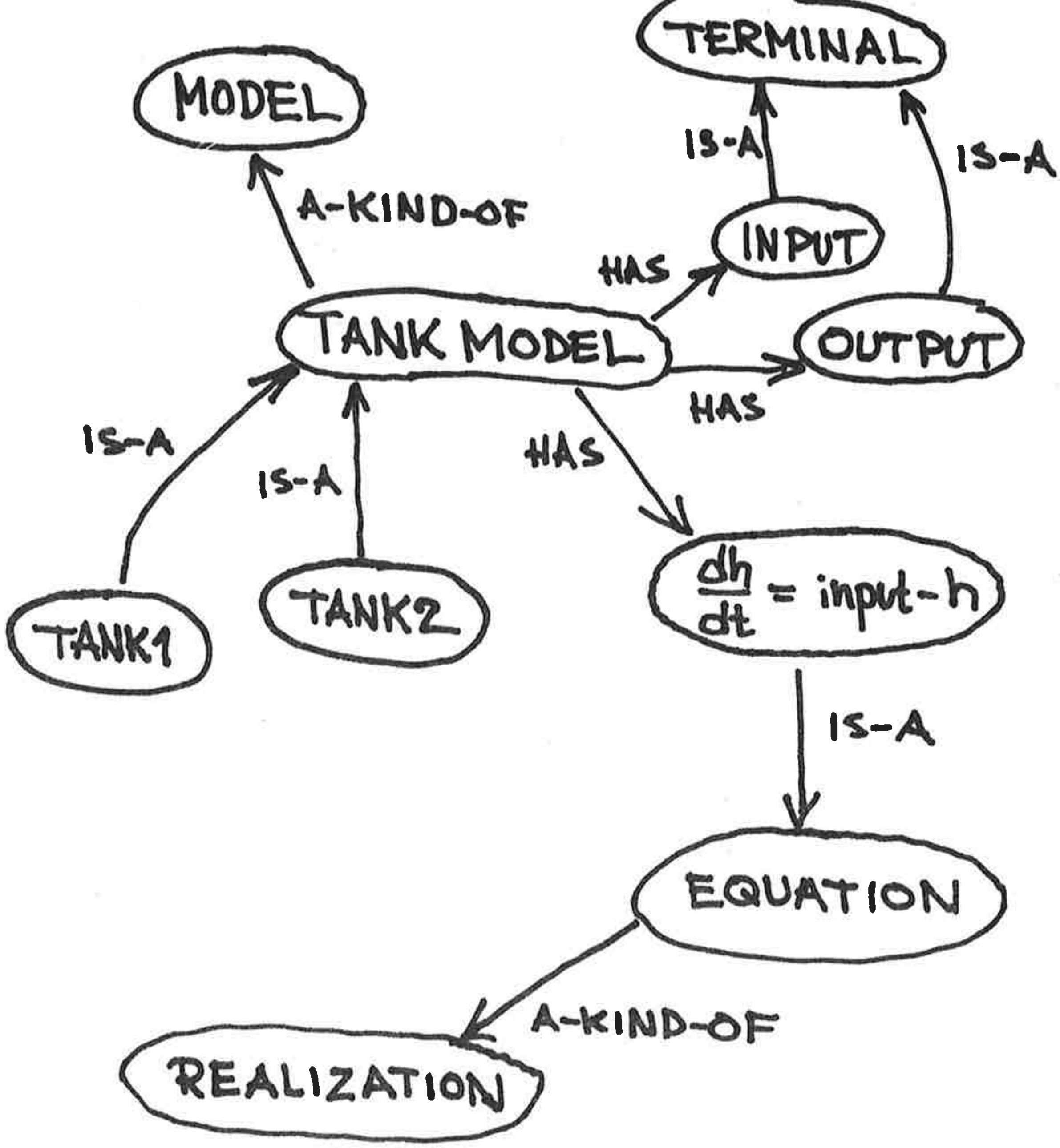
MEASURED BEHAVIOUR:

Real process data, simulation results...

PRESENTATION:

Icons, block diagrams,
animation pictures...

SEMANTIC NETS TO EXPRESS COMPLEX RELATIONS



Object Oriented Programming

An *object* is collection of data and procedures operating on that data.

A *class object* is a central description of a set of *instance objects*.

Class objects can be arranged in a hierarchy of subclasses and superclasses.

A subclass inherits properties from its superclasses.

Frames

A *frame* is a collection of slots.

A *slot* can have many *facets*.

Frames can be related by *is-a* and *a-kind-of* links.

Procedural knowledge can be attached to slots as *demons*.

— A THREE-LEVEL STRUCTURE —

META LEVEL

MODEL

TERMINAL

PARAMETER

REALIZATION

STRUCTURE

NONLINEAR

TYPE LEVEL

TANK-MODEL

INPUT, OUTPUT

SIZE

$$\frac{dh}{dt} = \text{input} - h$$

INSTANCE LEVEL

TANK1

SIZE = 1

INPUT = 5

⋮

TANK2

SIZE = 3

INPUT = 0

⋮

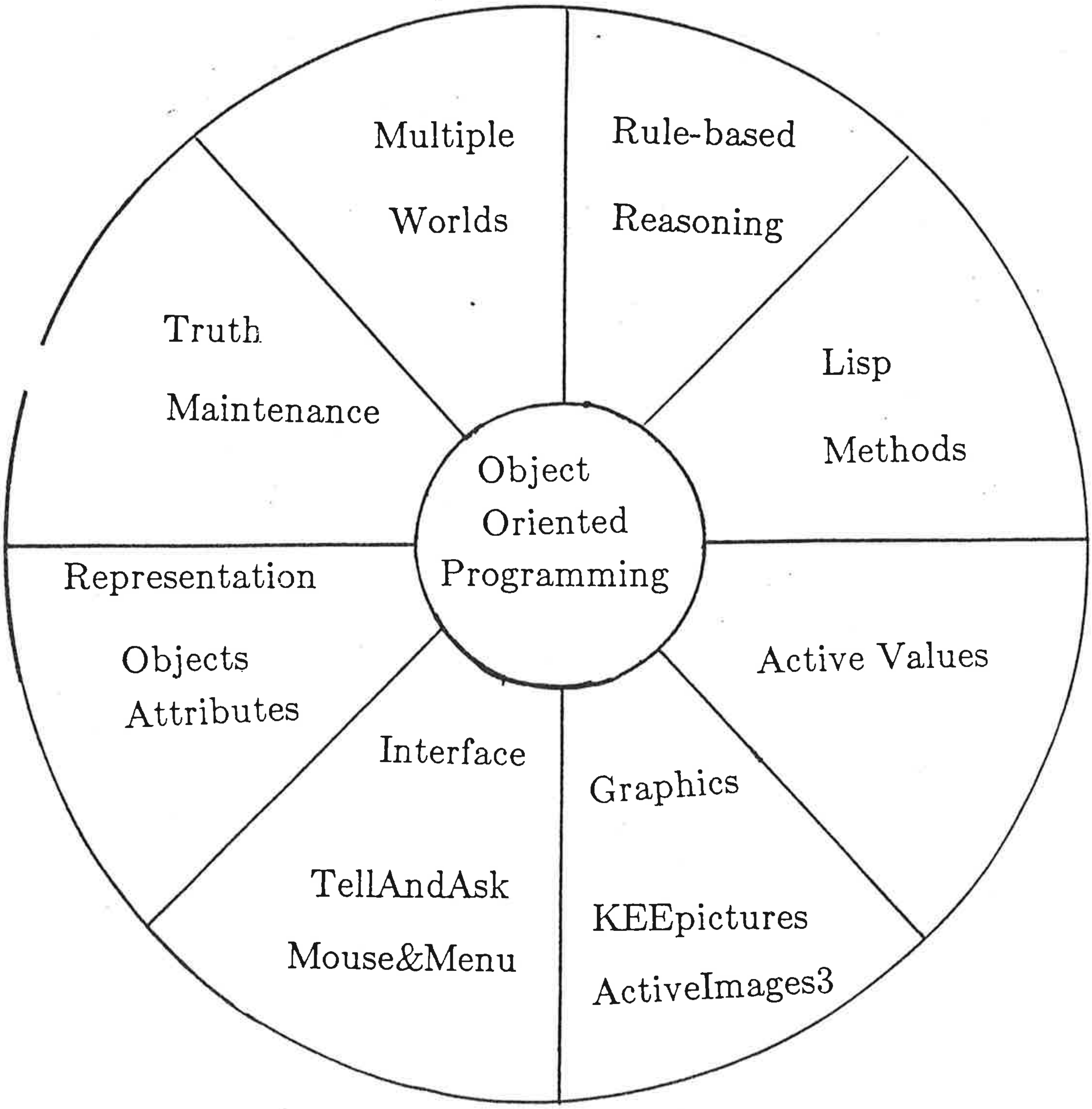
The Meta Level

MODEL:	
terminals:	
parameters:	
realizations:	
TERMINAL:	
subclass of:	variable
quantity:	
unit:	
range:	
PARAMETER:	
subclass of:	variable
default value:	
STRUCTURE:	
subclass of:	realization
submodels:	
connections:	
NONLINEAR:	
subclass of:	realization
equations:	

The Type Level

TANK:	
is a:	model
terminals:	q1, h
parameters:	A, a
realization:	tank-behaviour
TANK-BEHAVIOUR:	
is a:	nonlinear
equations:	$Adh/dt = q1 - q2$
	$q2 = a\sqrt{2gh}$
q1:	
is a:	input
part of:	tank
quantity:	water flow
unit:	m^3/s
h:	
is a:	output
part of:	tank
quantity:	water level
unit:	m
A:	
is a:	parameter
part of:	tank
default value:	0.1

KEE is a Hybrid System



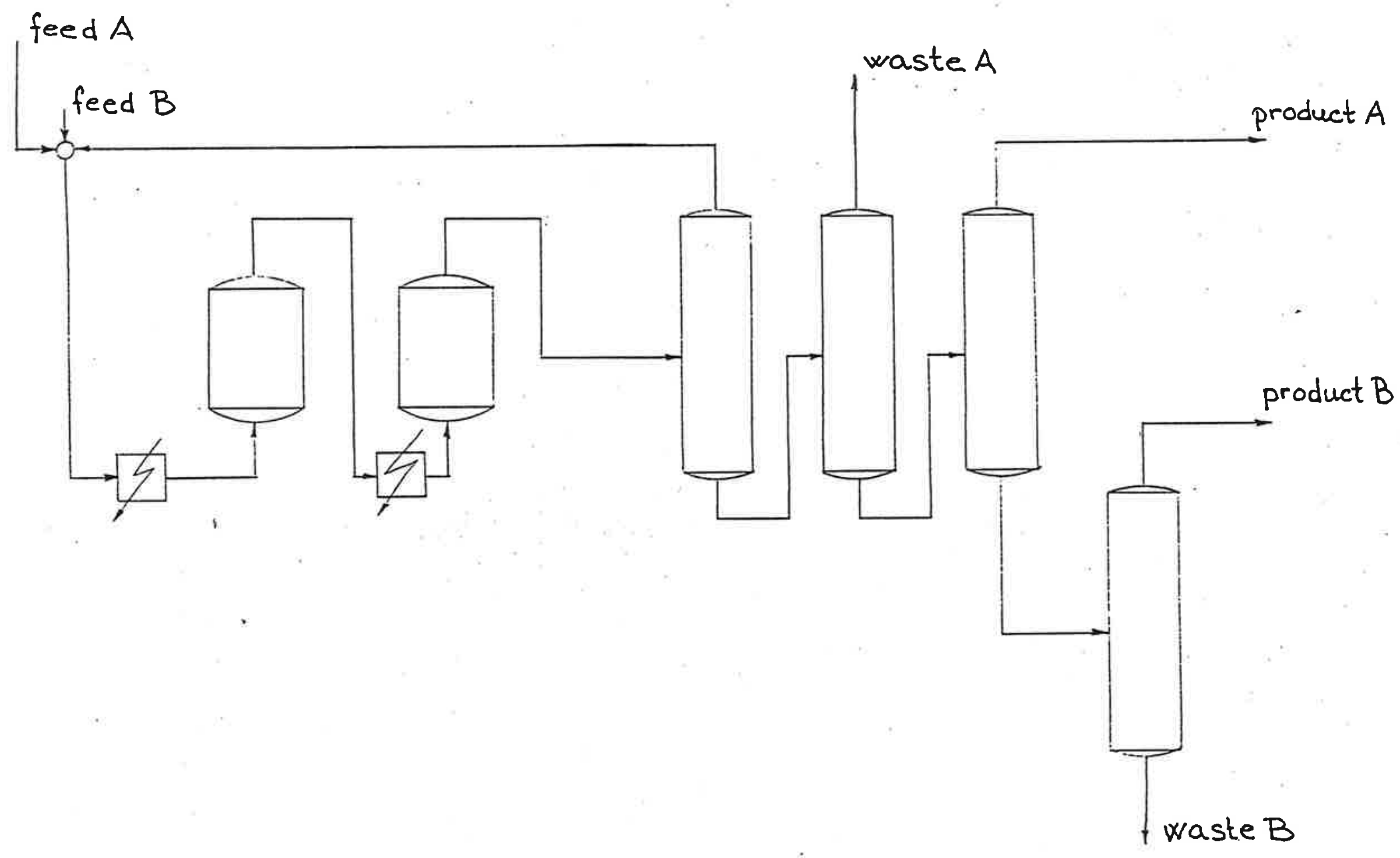
Application Project

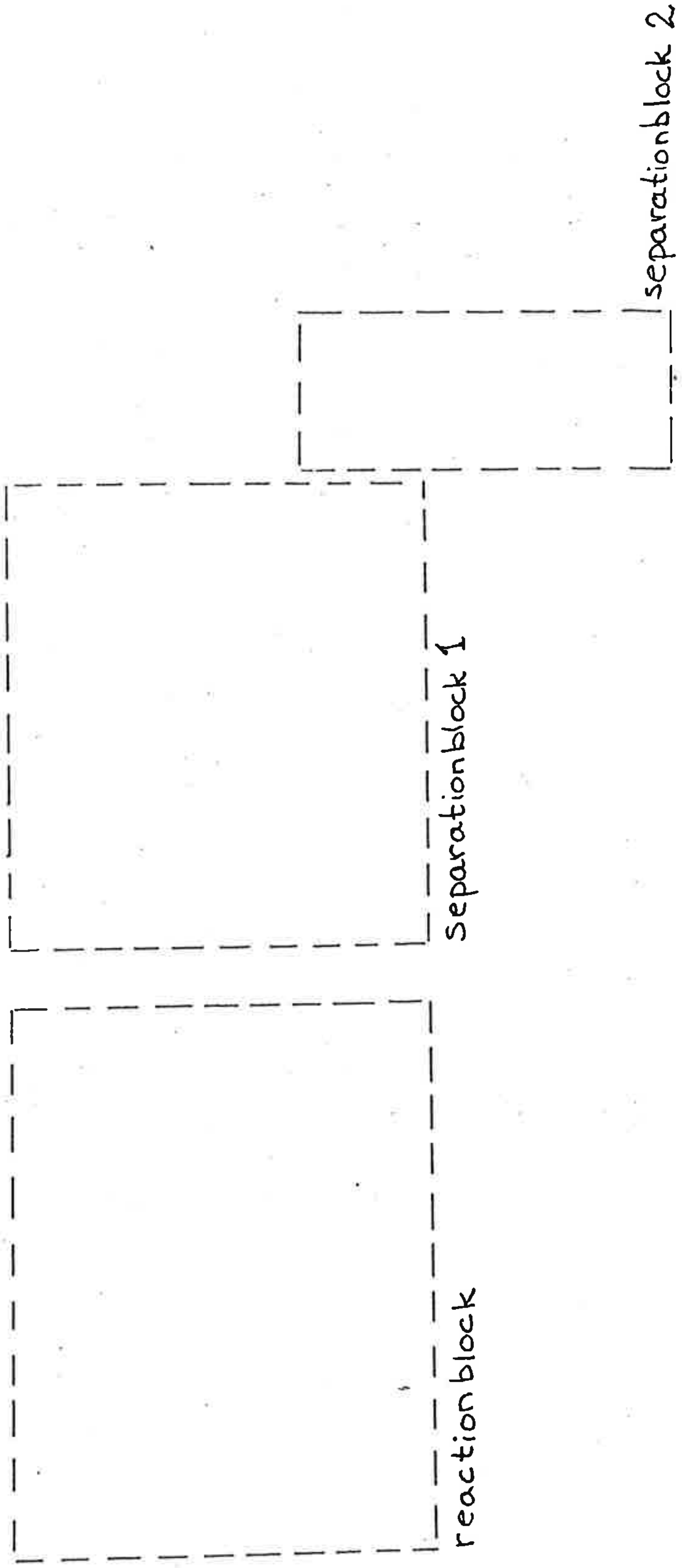
MODELLING AND SIMULATION OF CHEMICAL PROCESSES

Bernt Nilsson

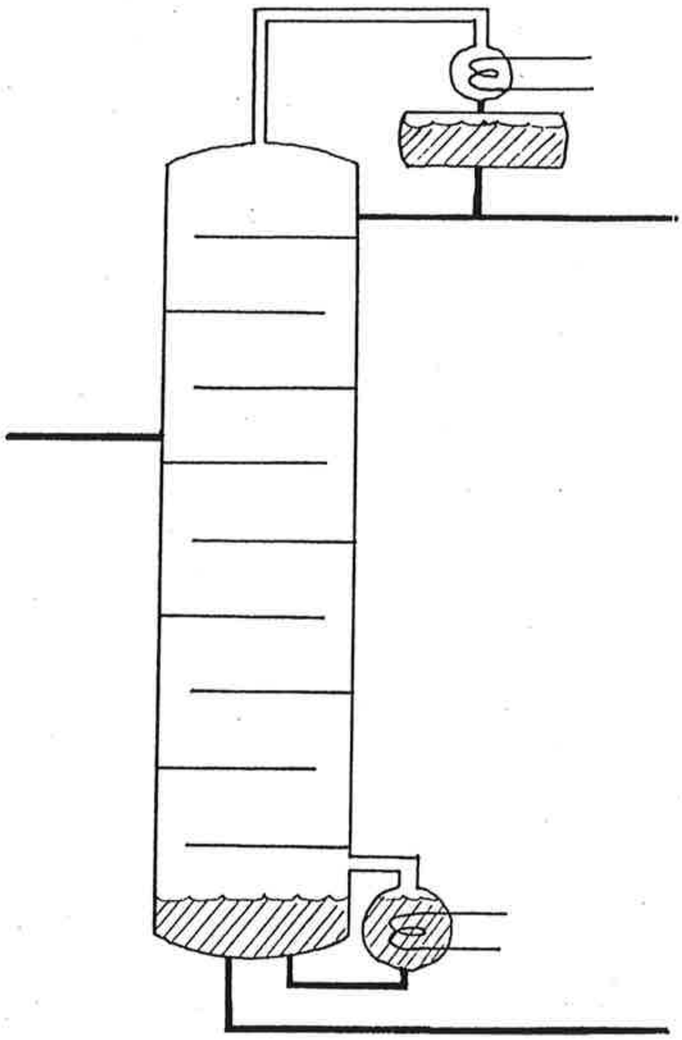
- Introduction
  Model structures in chemical processes
- An implementation in Hibliz
  A case studie
- New ideas in modelling chemical processes
- Conclusion

A Chemical Plant



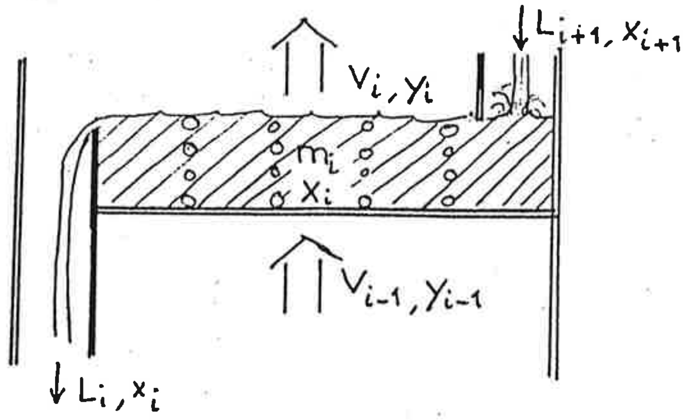

separationblock 2
separationblock 1
reactionblock

A DISTILLATION COLUMN



subunits :
- reboiler
- a number of trays
- condensor
- reflux drum

A Tray Model



Balance equation

Ackumulation	= In	− Out	+ Production
mass : $\frac{dm_i}{dt}$	$= (L_{i+1} + V_{i-1})$	$-(L_i + V_i)$	
component : $\frac{d(m_i x_i)}{dt}$	$= (L_{i+1}x_{i+1} + V_{i-1}y_{i-1})$	$-(L_i x_i + V_i y_i)$	

Flow equations

$$L_i = L_{io} + \frac{(m_i - m_{io})}{\beta} \qquad (= f(m_i))$$

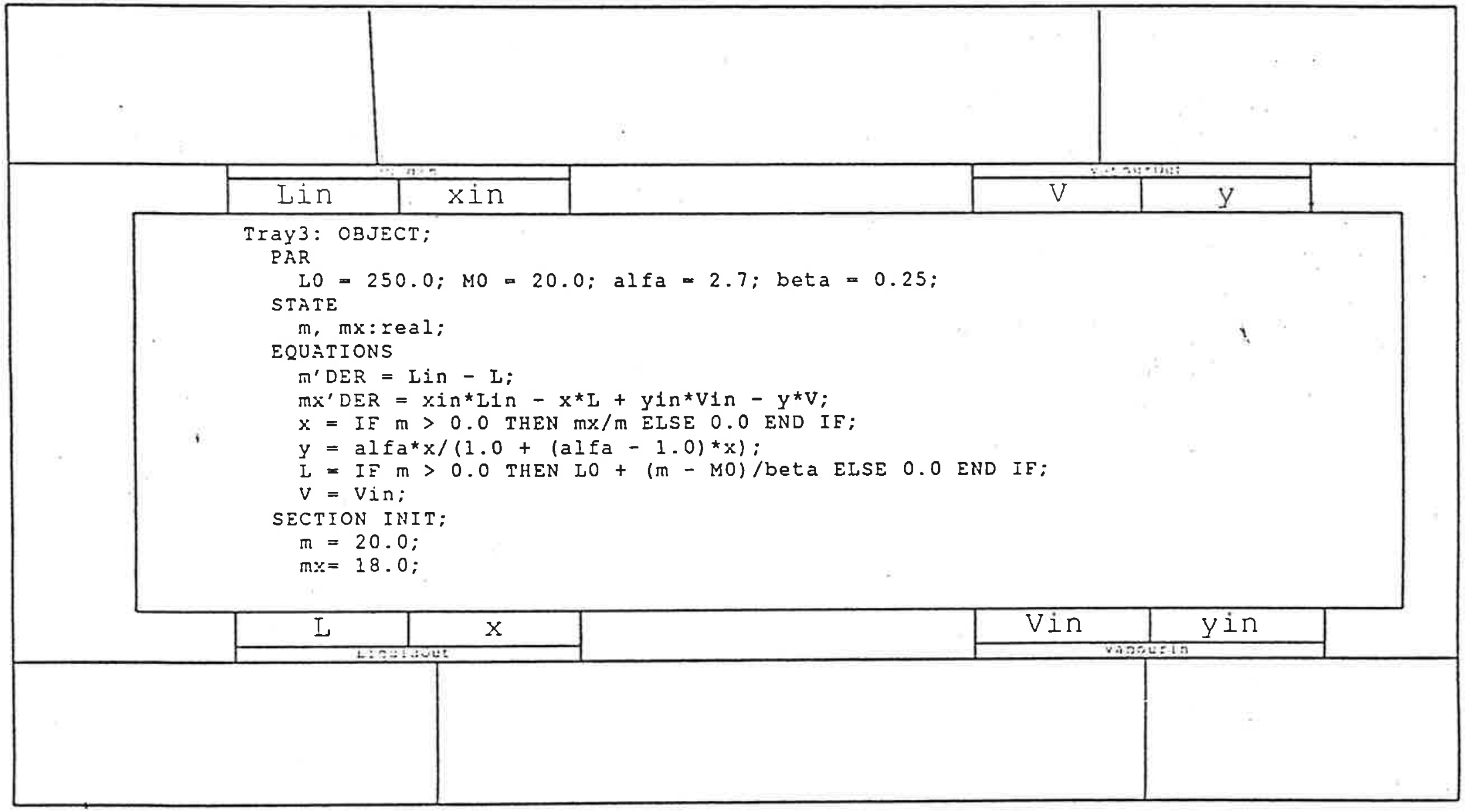
$$V_i = V_{i-1} \qquad (= f(V_{i-1}))$$

Phase equilibrium

$$y_i = \frac{\alpha x_i}{1 + (\alpha - 1) x_i} \qquad (= f(x_i))$$

Hibliz

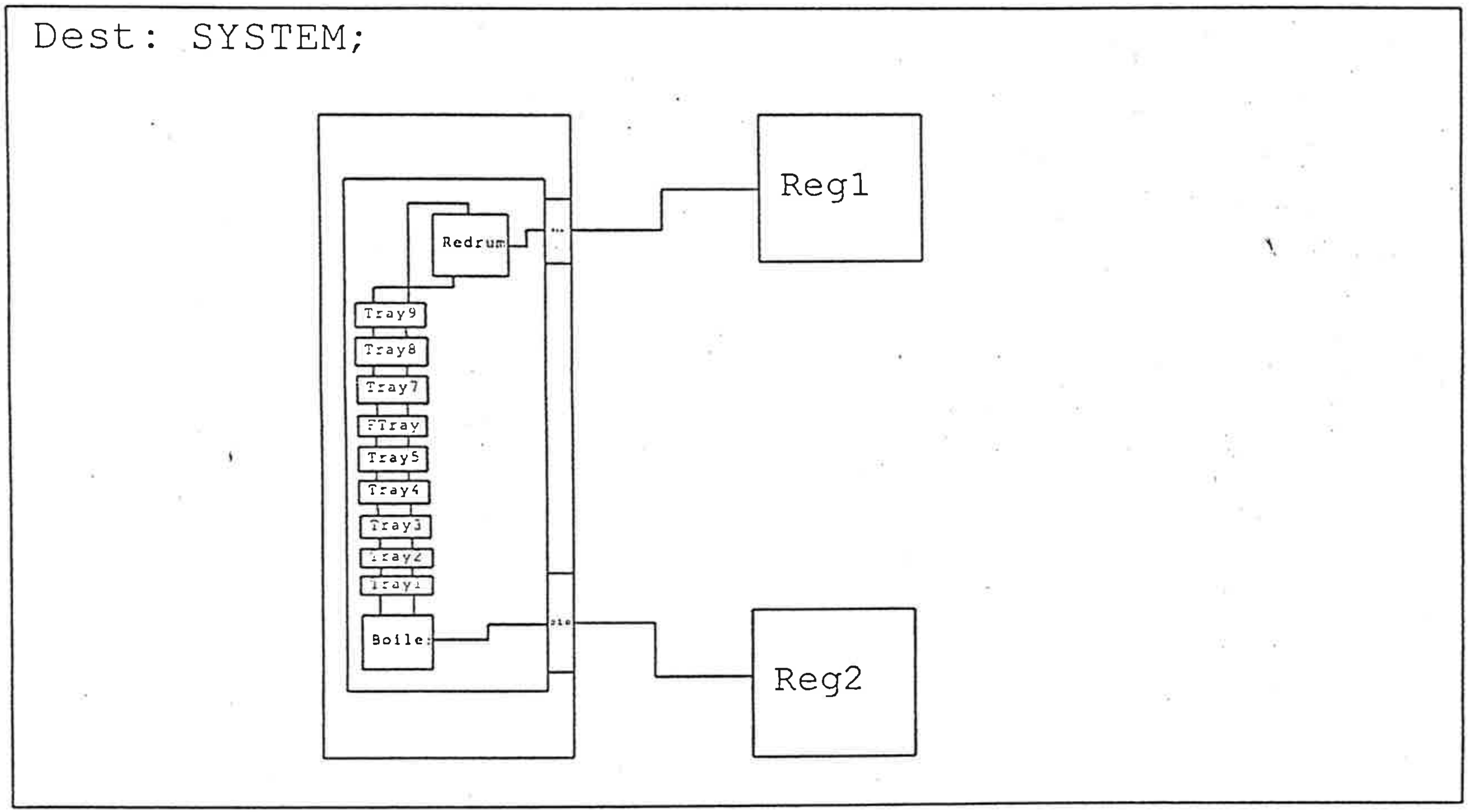
A Tray Model




```
Tray3: OBJECT;
  PAR
    L0 = 250.0; M0 = 20.0; alfa = 2.7; beta = 0.25;
  STATE
    m, mx:real;
  EQUATIONS
    m'DER = Lin - L;
    mx'DER = xin*Lin - x*L + yin*Vin - y*V;
    x = IF m > 0.0 THEN mx/m ELSE 0.0 END IF;
    y = alfa*x/(1.0 + (alfa - 1.0)*x);
    L = IF m > 0.0 THEN L0 + (m - M0)/beta ELSE 0.0 END IF;
    V = Vin;
  SECTION INIT;
    m = 20.0;
    mx= 18.0;
```

Hibliz

Distillation Model



SUMMARY:

Concepts in Hibliz that are important in modelling chemical processes

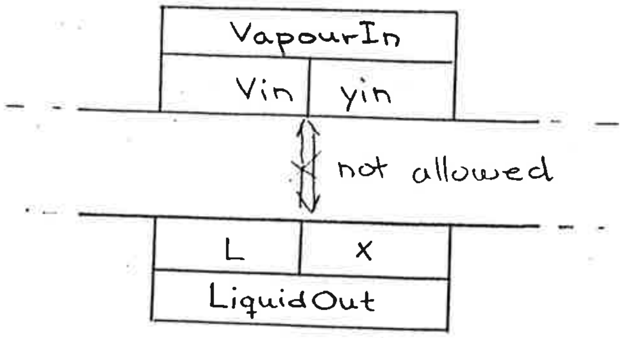
- Hierarchical model descriptions
- Model types and multiple instanses
- Cuts or terminals
- Connection mechanisms

Other needs not captured in Hibliz

- Media/Machine models
- Different model complexities
- Models supporting different views

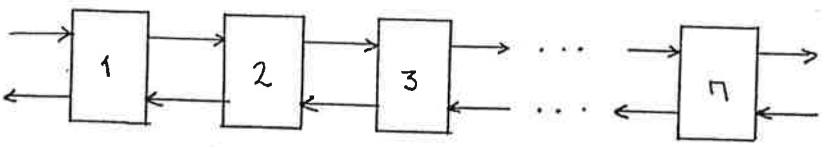
FUTURE DEVELOPMENTS

- Typing cuts

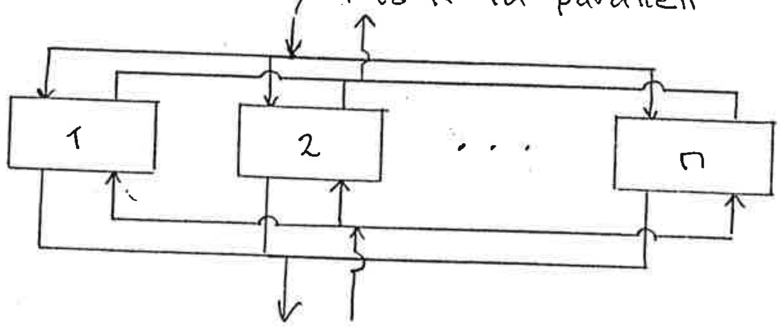


- Regular structures

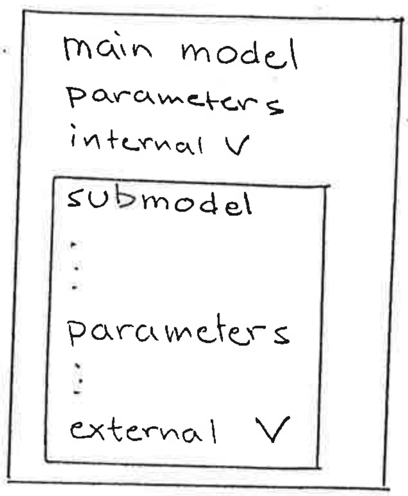
ex. connect tray 1 to n in serie



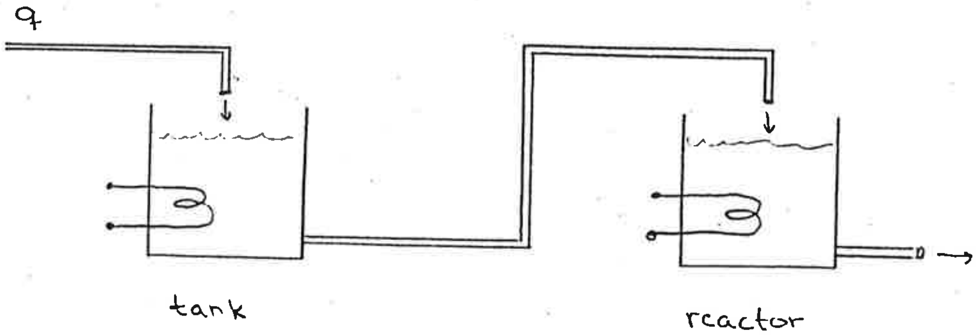
ex connect tray 1 to n in parallell



- Parameter assignment



MEDIA / MACHINE MODELS



- Machine models

  Balance equation

  ACK = IN − OUT + PROD

$$V_1 \frac{dc_1}{dt} = q \cdot c_{in} - q \cdot c_1$$

$$V_2 \frac{dc_2}{dt} = q \cdot c_1 - q\, c_2 + V_2 \cdot r_2$$

- Media models
  - density : $\rho = 1000$
  - reactionrate :

    $r_2 = k_0 e^{-\frac{E}{RT}} \cdot c_2$

    Valid when : • $T_{low} < T < T_{high}$

    • preceus of component B

    concentration of B $> c_{min}$

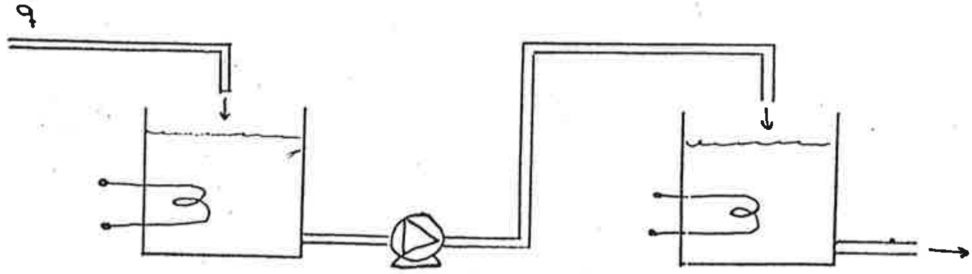
MEDIA/MACHINE MODELS

- Property propagation
  - A new cut concept

- Generic models
  - Tanks, pumps and pipes are very natural to model generic.

- Model libraries

DIFFERENT MODEL COMPLEXITIES



— Different Model complexities

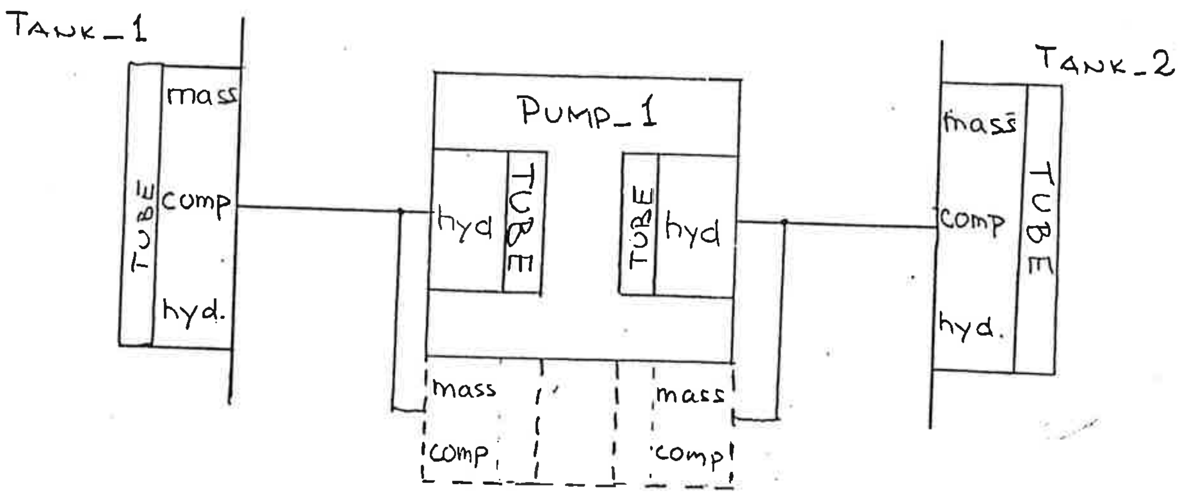
Tank model

- mass balance
- component balance
- hydrostatic balance

Pump model

- hydrostatic balance
- electric motor dynamics

— Cut translator and Advanced connections



MODELS SUPPORTING DIFFERENT VIEWS

- Study of a subset of the model equations
  - Ex. mass balance simulation
- Study of a set of submodels
  - Ex control design of a distillation column.
- Study of a minor part of the model.
  - Ex simulation of the reactors in the process

– Typing of equations.

mass_balance_type:

$$\frac{dm}{dt} = q_{in} - q_{out}$$

CONCLUSION

A new language for chemical process modelling requires a new set of modelling concepts in order to support the user with natural tools.

- Media/Machine models.
- Different model complexities.
- Models supporting different views.
- Graphic based interface

A PI Stepsize Control for the Numerical Solution of Ordinary Differential Equations

Kjell Gustafsson
Michael Lundh
Gustaf Söderlind

Contents

- Introduction
- Numerical Methods for Solution of ODE's
- Standard Stepsize Control Strategy
- New Stepsize Control Strategy
- Examples
- Conclusions

Integration Methods

Problem

$$\dot{y} = f(t, y), \qquad y(t_0) = y_0$$

Discretizations

1. One-step methods (RK)

$$\begin{cases} \dot{Y}_i = f\left(t_n + c_i h, y_n + h \sum_{j=1}^{r} a_{ij} \dot{Y}_j\right) & i = 1, \ldots, r \\ y_{n+1} = y_n + h \sum_{j=1}^{r} b_j \dot{Y}_j \end{cases}$$

2. Multi-step methods (BDF, Gear, Hampc)

$$\alpha_0 y_n + \alpha_1 y_{n+1} + \ldots + \alpha_k y_{n+k} =$$
$$h\left(\beta_0 f(t_n, y_n) + \ldots + \beta_k f(t_{n+k}, y_{n+k})\right)$$

The parameters in the discretizations are chosen to make the discretized equation resemble the original equation as well as possible.

Discretization Errors

The local truncation error (LTE) is defined as

$$d_n = y_{n+1} - y(t_{n+1}), \qquad y_n = y(t_n)$$

and the global error (GE) as

$$g_n = y_n - y(t_n)$$

An integration method is said to have order p if

$$\begin{aligned} \|d_n\| &= O(h^{p+1}), \qquad && h \to 0 \\ \|g_n\| &= O(h^p), && h \to 0 \end{aligned}$$

The value of GE determines the accuracy of the solution. By chosing an appropriate stepsize ($h_{n+1} = t_{n+1} - t_n$) one can in principal keep GE below a prescribed bound. GE can not be measured and is hard to estimate, but $\|g_n\|$ may be bound in terms of $\|d_n\|$.

Stepsize Control

Motivation

To take as long steps as possible (efficiency) while producing a solution within a given error bound (accuracy).

How it is done

1. The user specifies the desired accuracy of the solution as an acceptable error per unit step, *tol*.
2. When calculating the solution, the integration method also produces an error estimate r.
3. Choose the stepsize h such that $||r||/h$ comes as close as possible to *tol*.

The error is measured with the norm

$$||r|| = \max_i \left| \frac{r_i}{|y_i| + \eta_i} \right|,$$

Note

$$r \neq d, \qquad r \neq g$$

A Typical Stepsize Control Algorithm

For a method of order p we have

$$r = \phi h^{p+1}$$

ϕ is $O(1)$ as $h \to 0$, and it depends on the solution of the differential equation.

Given the error at step n, and assuming that ϕ does not vary, we can take the next stepsize h_{n+1} as

$$h_{n+1} = \left(\frac{tol}{\|r_n\|/h_n} \right)^{1/p} h_n$$

$$\Rightarrow \quad \frac{\|r_{n+1}\|}{h_{n+1}} = tol$$

Normally some limitations are included, and the control algorithm reads

$$h_{temp} = \gamma \left(\frac{tol}{\|r_n\|/h_n} \right)^{1/p} h_n$$

$$h_{n+1} = \begin{cases} h_n, & \text{if } \theta_{lo} h_n \le h_{temp} \le \theta_{hi} h_n \\ \theta_{max} h_n, & \text{if } h_{temp} > \theta_{max} h_n \\ h_{temp}, & \text{otherwise} \end{cases}$$

The step is rejected, if the error is too large in one step ($\|r\|/h > \rho \cdot tol$).

Typical parameter values:

$$\theta_{lo} = 1, \qquad \rho = 1.2$$
$$\theta_{hi} = 1.2 \qquad \gamma = 0.9$$
$$\theta_{max} = 2.0,$$

Rewriting the algorithm

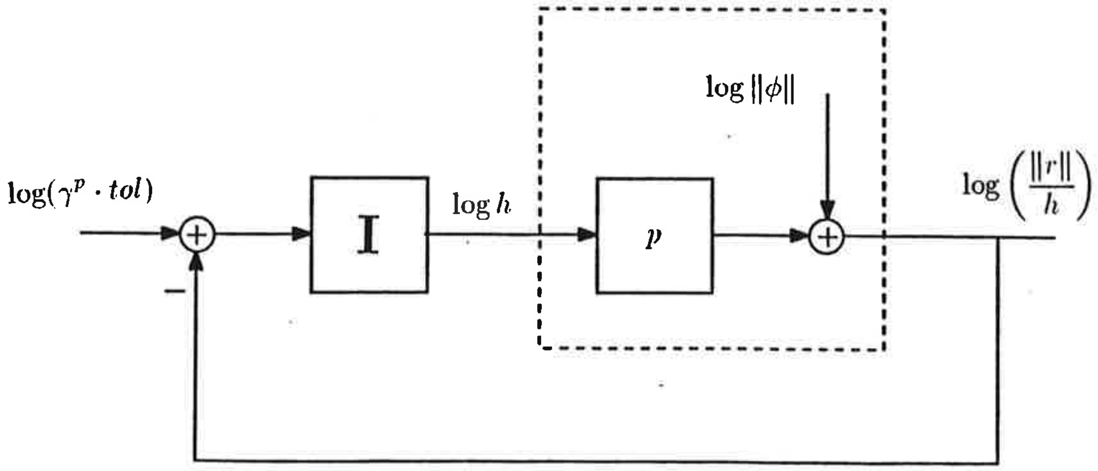
By expressing $\log h_{n+1}$ as a function of $\log h_n$ the control algorithm can be rewritten as

$$\log h_{n+1} = \log h_n + \frac{1}{p}\Big(\log(\gamma^p \cdot tol) - \log(\frac{\|r_n\|}{h_n})\Big).$$

Notice

- Integrating controller with gain $1/p$.
- The setpoint is $\gamma^p \cdot tol$.
- Limitation, one step anti-windup

An integrating controller has poor stabilizing properties. The asymptotic relation described earlier is a weak argument for choosing the integration gain equal to $1/p$.



New Control Strategy

Different ways to stabilize the system

- Modification of Method
- Modification of Controller

Discrete PI Controller

$$
\begin{aligned}
e_n &= \log(tol) - \log\Big(\frac{\|r_n\|}{h_n}\Big) \\
P_n &= K_P \cdot e_n \\
I_n &= I_{n-1} + K_I \cdot e_n \\
h_{n+1} &= \exp(P_n + I_n)
\end{aligned}
$$

PID-Controller ?

Complete Algorithm

- Stepsize Increase Limit (with Anti-Windup)
- Dead-Zone Omitted
- No Safety Factor γ
- $K_I \neq 1/p$

$$
\begin{aligned}
e_n &= \log(tol) - \log\left(\frac{\|r_n\|}{h_n}\right) \\
P_n &= K_P \cdot e_n \\
I_{temp} &= I_{n-1} + K_I \cdot e_n \\
h_{temp} &= \exp(P_n + I_{temp}) \\
h_{n+1} &= \begin{cases} \theta_{max} h_n, & \text{if } h_{temp} > \theta_{max} h_n \\ h_{temp}, & \text{otherwise} \end{cases} \\
I_n &= I_{temp} + (\log h_{n+1} - \log h_{temp}).
\end{aligned}
$$

More Compact Algorithm

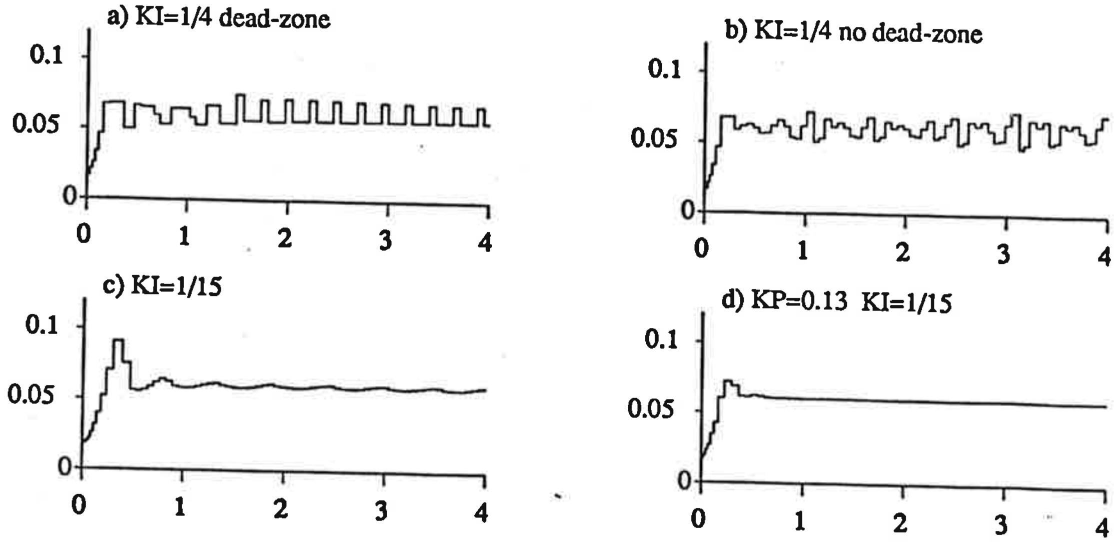
$$h_{temp} = \left(\frac{tol}{\|r_n\|/h_n}\right)^{K_I} \left(\frac{\|r_{n-1}\|/h_{n-1}}{\|r_n\|/h_n}\right)^{K_P} h_n$$

$$h_{n+1} = \begin{cases} \theta_{max} h_n, & \text{if } h_{temp} > \theta_{max} h_n \\ h_{temp}, & \text{otherwise.} \end{cases}$$

Two Parameter Sets for faster handling of rejected steps

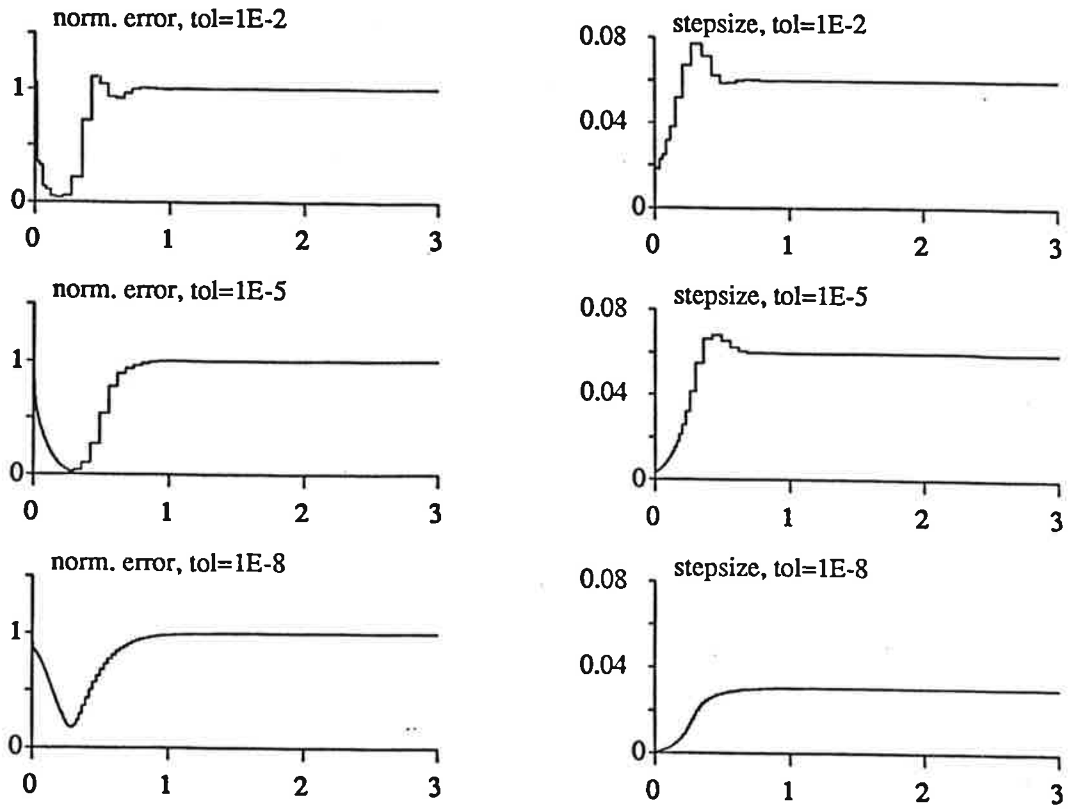
Normal case		Rejected case	
K_P	$= 0.13$	K_P	$= 0$
K_I	$= 1/15$	K_I	$= 1/5$
θ_{max}	$= 2.0$	θ_{max}	$= 2.0$
ρ	$= 1.2$	ρ	$= 1.2$

Modification Steps



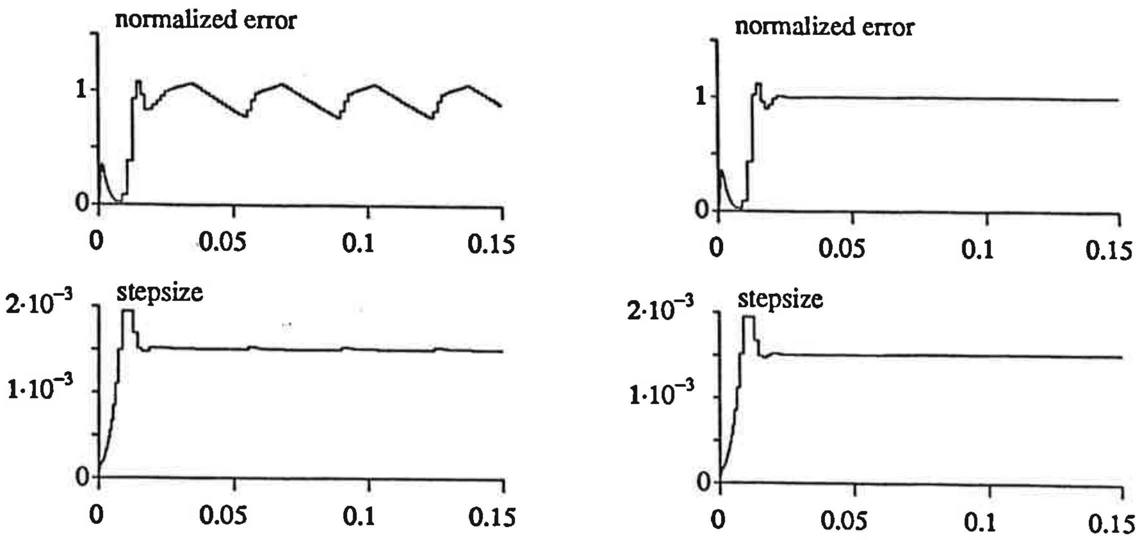
Problem 6

Stepsize for different tolerances



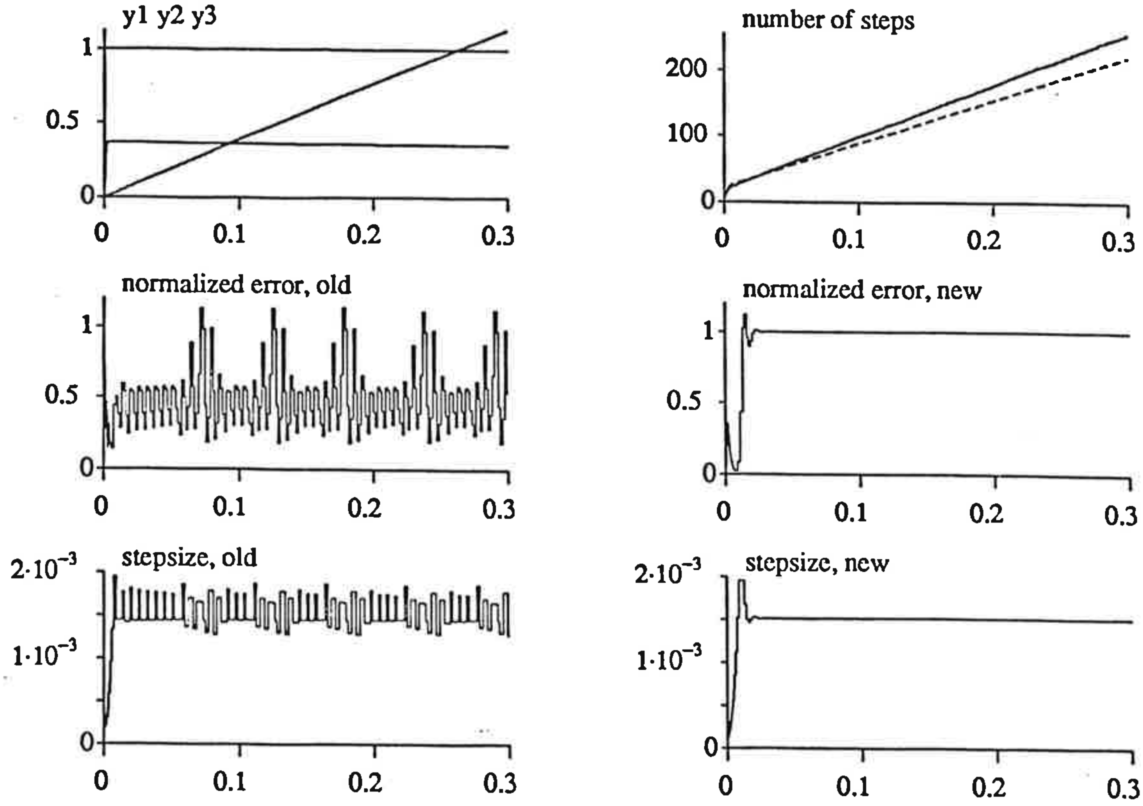
Problem 6

Influence of Dead-Zone



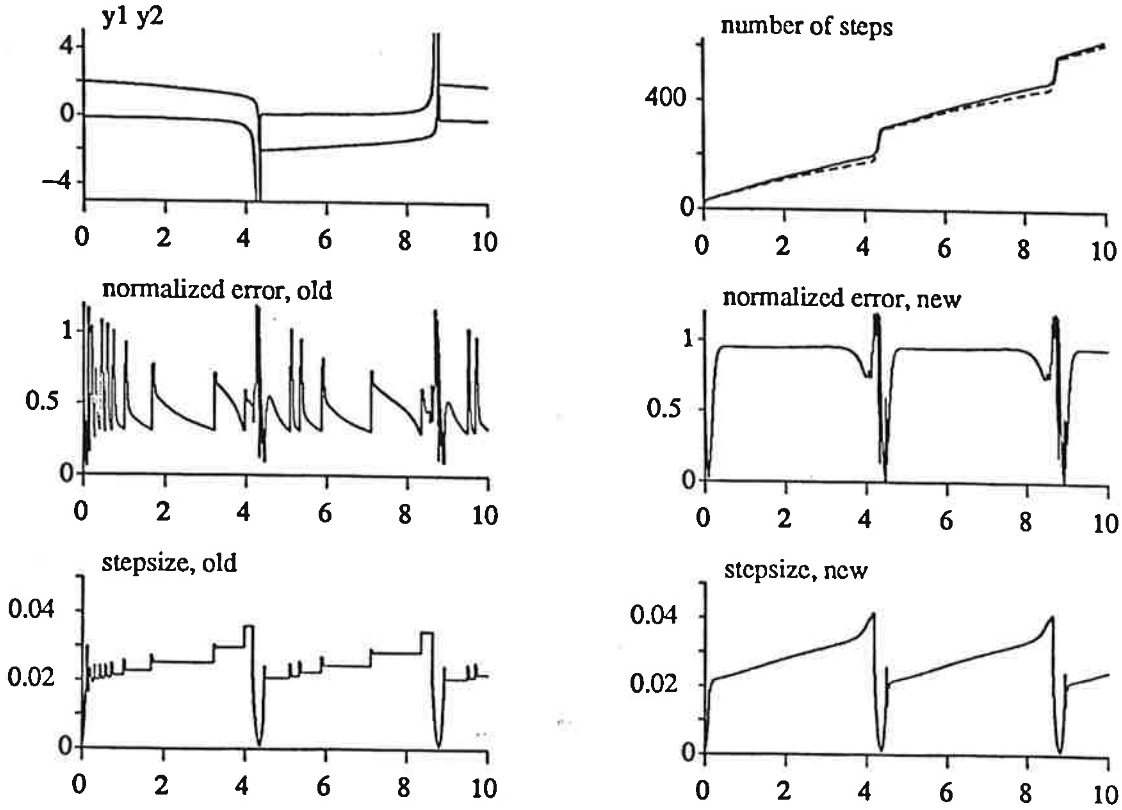
Problem 3

Comparison



Problem 3

Another Comparison



Problem 5 (stiff van der Pol oscillator)

Conclusions

PI-Control leads to

- ⋆ More Reliable Results
- ⋆ Improved Efficiency

Appendix

Problem 1 Problem B1 in [Enright et al. 1975].

$\dot{y}_1 = -y_1 + y_2$	$y_1(0) = 1.0$
$\dot{y}_2 = -100y_1 - y_2$	$y_2(0) = 0.0$
$\dot{y}_3 = -100y_3 + y_4$	$y_3(0) = 1.0$
$\dot{y}_4 = -10000y_3 - 100y_4$	$y_4(0) = 0.0$

Problem 2 Problem C2 in [Enright et al. 1975] with $\beta = 0.1$.

$\dot{y}_1 = -y_1 + 2$	$y_1(0) = 1.0$
$\dot{y}_2 = -10y_2 + \beta y_1^2$	$y_2(0) = 1.0$
$\dot{y}_3 = -40y_3 + 4\beta \cdot (y_1^2 + y_2^2$	$y_3(0) = 1.0$
$\dot{y}_4 = -100y_4 + 10\beta \cdot (y_1^2 + y_2^2 + y_3^2)$	$y_4(0) = 1.0$

Problem 3 Problem D2 in [Enright et al. 1975].

$\dot{y}_1 = -0.04y_1 + 0.01y_2y_3$	$y_1(0) = 1.0$
$\dot{y}_2 = 400y_1 - 100y_2y_3 - 3000y_2^2$	$y_2(0) = 0.0$
$\dot{y}_3 = 30y_2^2$	$y_3(0) = 0.0$

Problem 4 Problem E2 in [Enright et al. 1975].

$\dot{y}_1 = y_2$	$y_1(0) = 2.0$
$\dot{y}_2 = (1 - y_1^2)y_2 - y_1$	$y_2(0) = 0.0$

Problem 5 Problem E2 in [Enright et al. 1975] (sligthly changed).

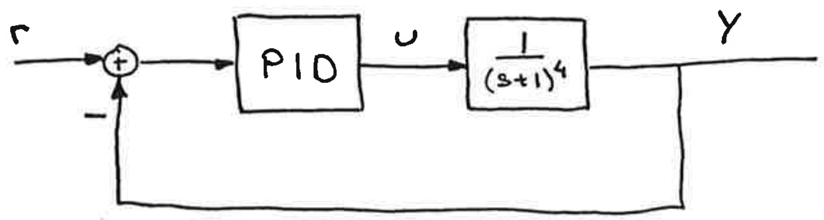
$\dot{y}_1 = y_2$	$y_1(0) = 2.0$
$\dot{y}_2 = 50(1 - y_1^2)y_2 - 10y_1$	$y_2(0) = 0.0$

Problem 6 Problem E3 in [Enright et al. 1975].

$\dot{y}_1 = -(55 + y_3)y_1 + 65y_2$	$y_1(0) = 1.0$
$\dot{y}_2 = 0.0785(y_1 - y_2)$	$y_2(0) = 1.0$
$\dot{y}_3 = 0.1y_1$	$y_3(0) = 0.0$

Problem 7 Brusselator, a. $\beta = 3.0$, b. $\beta = 8.533$

$\dot{y}_1 = 1.0 + y_1^2 y_2 - (\beta + 1.0)y_1$	$y_1(0) = 1.3$
$\dot{y}_2 = \beta y_1 - y_1^2 y_2$	$y_2(0) = \beta$



$$\text{PID:} \quad u = k\left(br - y + \frac{1}{T_i p}(r-y) - \frac{T_D p}{\frac{T_D}{N} p + 1} y \right)$$

$k = 0.87, \quad T_i = 2.7, \quad T_D = 0.69, \quad b = 1, \quad N = 5$

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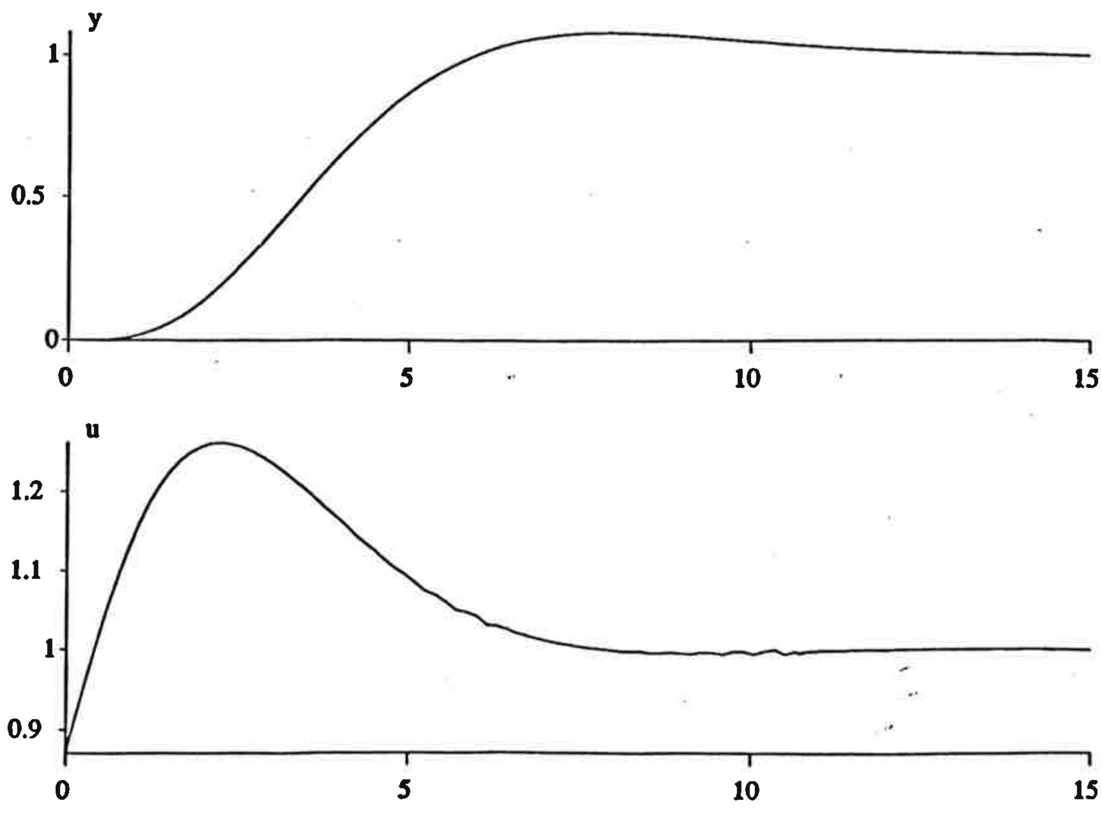

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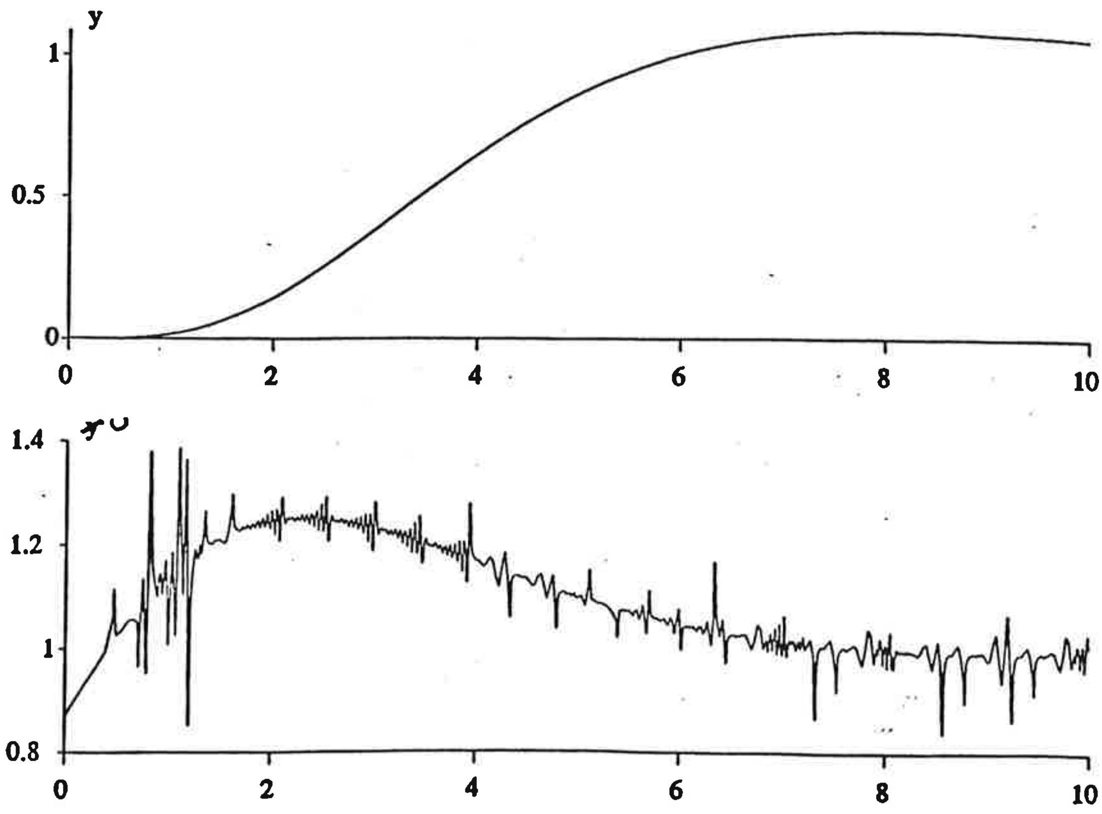

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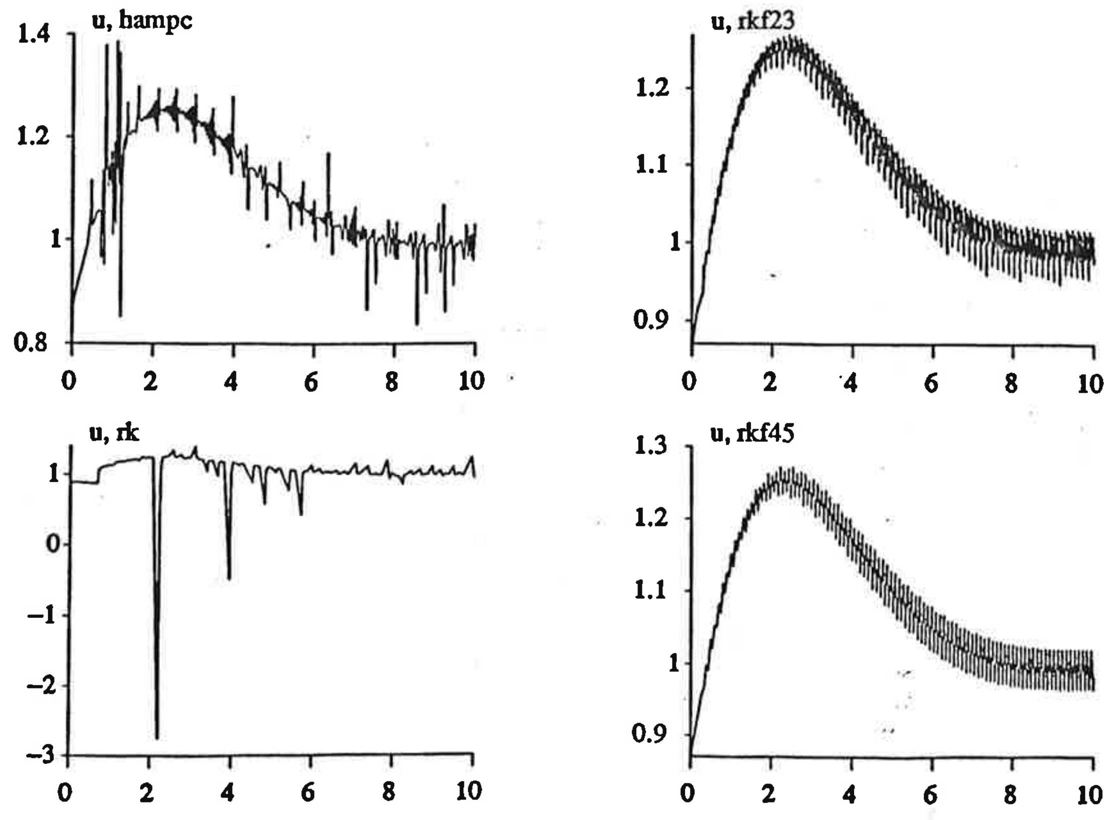

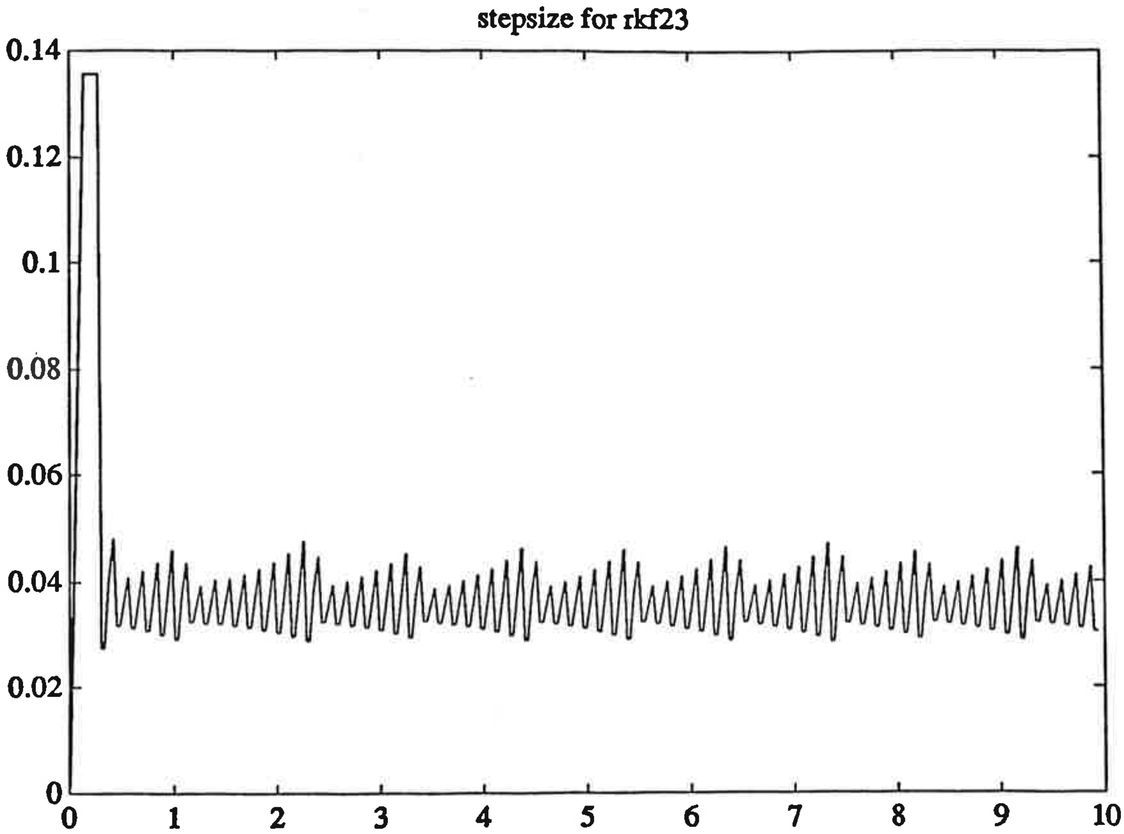

stepsize for rkf23
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
1
2
3
4
5
6
7
8
9
10

PR

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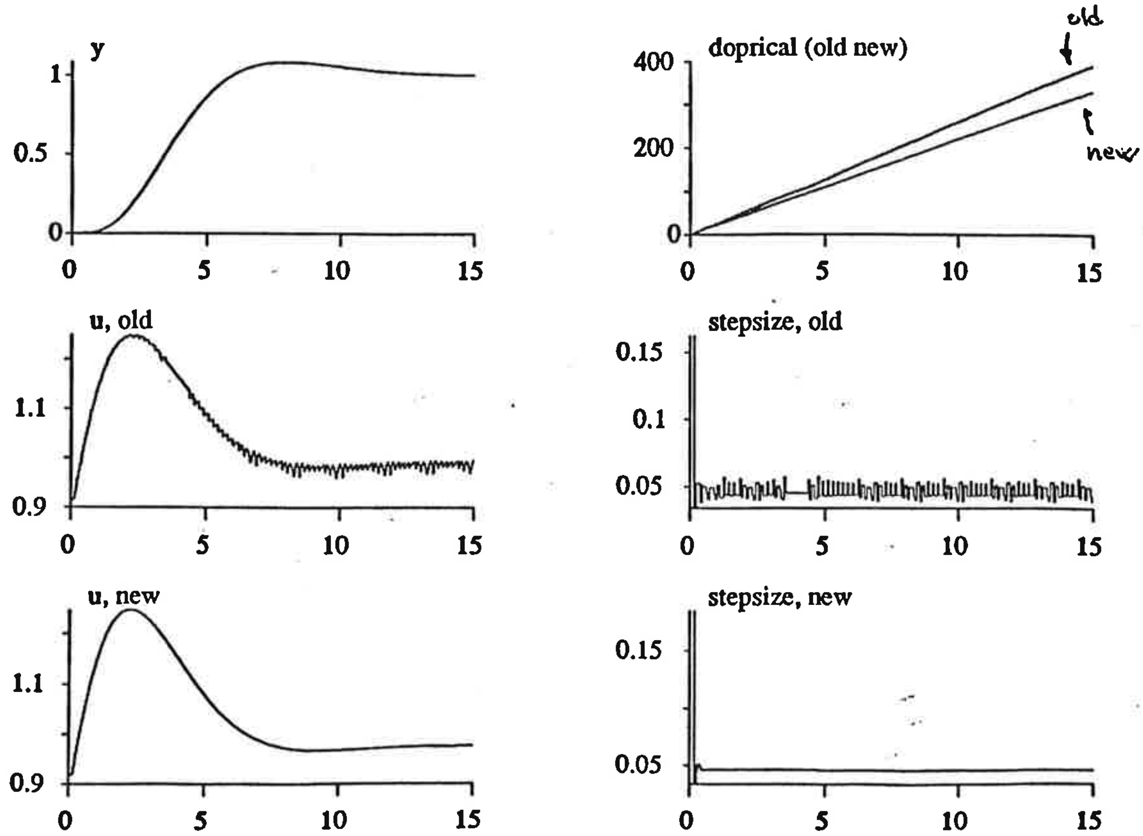

INTERNATIONAL CONTACTS

1. SERC, UK
2. DTH, Denmark
3. G2, Gensym Corp.
4. University of Maryland

SERC, UK

1. Joint SERC/STU Workshop on Expert Systems and Data Bases for Control System Design and Application, Cambridge, UK, April 1987
   K-E Årzén: *Knowledge based controllers*
   K.J. Åström: *Expert control methods for assessment of achievable control performance*
   P. Persson: *An expert system interface for Idpac*
2. ECSTASY
   Env. for Control System Theory Appl. and SYnthesis
   - Embryo, early January 1988
   - Interfaces to ACSL and Matlab
   - Implemented using PA SET tools
   - Runs on the SUN 3/50
   - We will be a β-test site
3. Cambridge Control markets Simnon in the UK.

DTH, DENMARK

Morten Lind is a newly appointed professor at Servolaboratoriet.

His interests include:

1. Qualitative and quantitative modelling
2. Control design methods for complex plants
3. Modelling of the design procedure
4. Categorization of plant knowledge for the design
5. Use of design knowledge for supervision and fault diagnosis.

We have visited each other a number of times and discussed joint projects:

1. Analyse some existing designs from the perspective of the three level design model.
2. Analyse the pole placement design procedure and develop a knowledge base.

GENSYM CORP.

We have got G2 for the Symbolics to a low price.

We have a good dialogue with Robert Moore.
He visited us in October 1987.

They need better tools for model development in G2.

Björn Tyreus, DuPont, USA

UNIVERSITY OF MARYLAND

1. Exchanged Hibliz for software for symbolic manipulation of non-linear systems.
2. Exchanged Simnon for their design software.
3. The CONSOLE-SIMNON tandem for optimization-based design (Andre Tits).
4. Models of chemical processes (A. Asbjoernsson). There is a possibility of joint projects.

POSSIBLE FUTURE PROJECTS

- Model development and knowledge bases
  - General tools and concepts
  - Application dependent tools
    - Chemical processes
    - Power plants
- Qualitative analysis of quantitative models
  - Order of magnitude reasoning
  - Insight
- Qualitative modelling and simulation
  - Tools and concepts
  - Incomplete and uncertain information
- Control design
  - Knowledge bases and algorithms
- Automatic implementation of controllers
- Expert control and real-time expert systems
- Tools for data analysis
- Simnon II

POSSIBLE DIRECTIONS
in
Expert Control and Real-time Expert Systems

- Continuation of the thesis project

  The real-time expert system framework

  - Port to Symbolics – PC AT environment
  - User interface
  - Other extensions

  The control parts

  - Auto-tuning
  - Adaptation

- Expert systems for process monitoring and fault detection

  Active research area

  G2

  Morten Lindh

  Real complex process

- Fuzzy or rule-based control

  Compare with traditional PID control

  Investigate recent qualitative methods

STYRELSEN FÖR TEKNISK UTVECKLING
SWEDISH NATIONAL BOARD FOR TECHNICAL DEVELOPMENT

P R O T O K O L L

från sammanträde med STUs styrgrupp för ramprogram CACE den 26 mars 1987 kl 9 00 - 13 00 på STU.

Närvarande: Sven Gunnar Edlund
Claes Källström
Sven Erik Mattsson
Gustaf Söderlind
Karl Johan Åström
Arne Otteblad

§ 1 Formalia

Sven Gunnar Edlund valdes till ordförande för sammanträdet. Arne Otteblad valdes till sekreterare, Sven Erik Mattsson valdes till justeringsman.

Föregående protokoll godkändes. Dagordningen godkändes.

§ 2 Karl Johan Åström meddelade att en arbetsstation av märket Symbolics nu inköpts för anslaget på FRN-ramen.

§ 3 Beträffande det CACE-seminarium som genomfördes den 25 mars rådde enighet om att det gjordes fina presentationer och att seminariet som helhet genomfördes väl. Det betonades att dessa samlingar inom ett ramprogram är viktiga som inspirationskälla och att den "feedback" som kom från industrisidan är viktig för att minska gapet mellan forskningen och industritillämpningen.

§ 4 Det fortsatta CACE-programmets målsättning diskuterades intensivt. Stor enighet rådde om att det var nödvändigt att göra målet betydligt snävare än det hade varit under ramprogrammets första tre år. Expertreglerings-projekt~~a~~ ansågs lämpligt att driva utanför ramprogrammet med hjälp av andra finansieringskällor. Den stora skiljelinjen gällde om man skulle satsa på processanalys och identifiering eller modellutveckling och simulering. Så småningom enades styrgruppen om att tillstyrka en huvudinriktning mot en verktygslåda för modellutveckling och simulering med förhoppningen att man nästa 3-års-period skulle kunna arbeta med en verktygslåda för processanalys och identifiering.

§ 5 Sven Erik Mattsson redovisade ett utkast till ansökan avseende att använda de CACE-pengar som återstod för budgetåret 1986/87 till inköp av arbetsstationer (i enlighet med tidigare planer). Styrgruppen tillstyrkte att resterande medel användes för detta ändamål.

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§ 6 Sven Erik Mattsson och Arne Otteblad fick i uppdrag att arbeta vidare med programplanen för ramprogrammets fortsättning utgående från det utkast som presenterades vid mötet (se bilaga till originalprotokollet) och följande disposition:

1. Bakgrund
2. Motiv för att fullfölja programmet
3. Målsättning för det fortsatta ramprogrammet
4. Plan för den fortsatta verksamheten
5. Nyttiggörande och resultatspridning

App. A. Genomförda pilotprojekt

B. Kontaktnät

Innehållsmässigt var styrgruppen nöjd med utkastet till programplan. Beträffande ramprogrammets namn tillstyrkte styrgruppen en ändring till "Datorbaserade hjälpmedel för utveckling av styrsystem".

§ 7 Nästa sammanträde bestämde man genomföra som telefonmöte den 3 juni kl 13. Härvid skall ansökningar för nästa budgetår diskuteras.

Vid protokollet

Arne Otteblad
STU

Justeras
Sven Erik Mattsson

Sven Erik Mattsson
LTH

STYRELSEN FÖR TEKNISK UTVECKLING
SWEDISH NATIONAL BOARD FOR TECHNICAL DEVELOPMENT

P R O T O K O L L

från telefonmöte med STUs styrgrupp för ramprogram CACE den 3 juni 1987 kl 13 00 - 14 00

Deltagare: Sven Gunnar Edlund
Karl Eklund
Sven Erik Mattsson
Eric Sandewall
Gustaf Söderlind
Arne Otteblad

§ 1 Formalia
Ordförande: Sven Gunnar Edlund
Sekreterare: Arne Otteblad
Justeringsman: Sven Erik Mattsson

§ 2 Programplanen för ramprogrammet i det utförande som godkänts av STUs styrelse den 5 maj 1987 hade bifogats kallelsen. Styrgruppen noterade att planen blev bra. Eric Sandewall kommenterade speciellt realtidskunskaps-system och planstyrda system och skall ta initiativ till diskussioner av deras gränsyta mot CACE.

§ 3 a/ En ansökan från Karl Johan Åström med titeln "Verktyg för modellutveckling och simulering" förelåg. Den av-såg verksamheten vid institutionen för reglerteknik LTH under budgetåret 1987/88 till en kostnad på 1 360 kkr. Styrgruppen konstaterade att projektet stämde väl med programplanen och innehöll alla de moment som planerats ingå i programverksamheten. Styrgruppen till-styrkte medel till projektet i äskad omfattning.

b/ Från SSPA Maritime Consulting AB förelåg en ansökan på 140 kkr under 1987/88 avseende "Utveckling av animerings-metod för fartygssimulering". I Claes Källströms borto-varo konstaterade styrgruppen att man ej hade tillräcklig information för att ta ställning till projektet. Under-tecknad sekreterare fick i uppdrag att diskutera projek-tet vidare med Claes Källström.

§ 4 Från Percy Hammond i England hade ett förslag till avtal mellan STU och SERC angående programutbyte och samarbete inom CACE-området kommit till STU via Karl Johan Åström.

Styrgruppen hade en kort diskussion kring avtalet och betonade speciellt att det bör vara "symmetriskt". Under-tecknad fick i uppdrag att diskutera avtalet vidare med Karl Johan Åström.

§ 5 Nästa styrgruppsmöte skall hållas den 25 november 1987 i Lund.

Vid protokollet
Arne Otteblad
Arne Otteblad
STU

Justeras
Sven Erik Mattsson
Sven Erik Mattsson
LTH

STU 2 b.

STYRELSEN FÖR TEKNISK UTVECKLING
SWEDISH NATIONAL BOARD FOR TECHNICAL DEVELOPMENT 1987-12-30

Arne Otteblad/ksb

PROTOKOLL

från möte med STUs styrgrupp för ramprogram CACE den 25/11 1987 kl 10,00 - 17,00 vid Institutionen för reglerteknik, Lunds tekniska högskola.

Närvarande: Styrgruppsmedlemmar:

Sven Gunnar Edlund
Claes Källström
Gustaf Söderlind
Arne Otteblad

Projektengagerade:

Sven Erik Mattsson
Gustaf Olsson (delvis)
Dag Brück
Karl-Erik Årzén
Mats Andersson
Kjell Gustafsson
Bernt Nilsson
Tomas Schönthal

§ 1 Följande formaliteter avklarades inledningsvis:

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

Den föreslagna dagordningen godkändes.

Protokoll från sammanträde den 26/3,87 och telefonmöte den 3/6,87 godkändes.

§ 2 I samband med genomgången av föregående protokoll (3/6,87) gjordes följande kommentarer.

a) (§2). Eric Sandevall har gjort en beskrivning av sitt projekt "Planstyrda system". Arne Otteblad skickar kopia till styrgruppsledamöterna.

b) (§3). Ansökan från SSPA Maritime Consulting AB har avförts i samråd med sökanden.

c) (§4). SIMNON finns nu tillgänglig som en kommersiell produkt i England.

§ 3 Sven Erik Mattsson, Mats Andersson, Bernt Nilsson och Kjell Gustafsson gav med hjälp av overheadbilder (kopior utdelades) en fin översikt över huvudprojektet och dess tillämpningsprojekt.

Speciellt kan nämnas att Sven Erik M redovisade problem med uppdatering och underhåll av arbetsstationen IRIS 2400. Styrgruppen tillstyrkte en uppgradering till IRIS 2400 Turbo (kostnad cirka 20 000 dollar).

STYRELSEN FÖR TEKNISK UTVECKLING
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En livlig diskussion fördes rörande underhåll av simuleringsmodeller efter utvecklingsfasen. Styrgruppen var enig om att dessa aspekter är utomordentligt viktiga och bör beaktas i det fortsatta arbetet.

§ 4 Gustaf Olsson berättade om IT-Centrum-Syd och dess IT-LAB. Det hela är tänkt som en flexibel organisation som verkar långsiktigt.

Arne O informerade om programmet "Driftutvecklingssystem för processindustrin" och dess koppling till CACE diskuterades.

§ 5 Med utgångspunkt från presentationer som gjordes av Sven Erik M, Karl Erik Å och Sven Gunnar E diskuterades den framtida programverksamheten på det reglertekniska området. Styrgruppens ledamöter funderar vidare över detta och fortsätter diskussionerna vid nästa sammanträde.

§ 6 Nästa sammanträde beslöts hållas i Lund den 20 april 1988.

§ 7 Dagens sammanträde avslutades med demonstrationer bl a av G2.

Vid protokollet

Arne Otteblad
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Justeras

Sven Erik Mattsson

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