Activity Report: Automatic Control 1980-1982

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A C T I V I T Y   R E P O R T

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1980 - 1982

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Title and subtitle

Activity Report 1980-1982

Abstract

The report surveys the activities at the Department of Automatic Control, Lund Institute of Technology, during the academic years 1980-81 and 1981-82. At the civilingenjör level ($\approx$ MS) seven different courses are given on regular basis. About 800 students have participated during these two years. Also 43 MS-theses and two PhD-theses have been completed.

The major areas of research have been adaptive control, robustness, system identification, and computer aided design of control systems.

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1. INTRODUCTION

The activities in the academic years 1980/81 and 1981/82 are reported here. On the teaching side a substantial effort has been devoted to planning for new teaching laboratories. This has included travel, discussions and extensive experimentation. The work is very time-consuming but we expect it to have a significant impact on future education. New courses on computer-controlled systems and real-time programming have also been developed. This is described in more detail in Section 2. The planning of teaching programs was given a real boost during a trip that the department made to our colleagues in The Netherlands, see Section 6.

During this period the major research efforts followed the previously established lines. The major methodological projects carried out during the period were adaptive control and computer aided design. The computer aided design project was terminated during the period. The major reason is that we have developed a set of useful tools and we believe that good feedback from many different users are needed to take the next step. Research in adaptive control has been continued with efforts devoted to robustness, multivariable control and dual control. This field is so rich that we expect to continue for a long time. Preliminary exploration of nonlinear control have also been persued in connection with Gutman's thesis. We expect this effort to be continued. With regards to application a new project control of wind turbine generators has been initiated. This work is done in close cooperation with Sydkraft. This is described in Section 3. Our old interest in control of activated sludge processes has also been reactivated.

The most drastic changes have been in computer related research. Together with the Department of Computer Engineering and with the support of STU we have started a center for industrial computer systems (CID). The idea is to take a more serious look at implementation issues and computer hardware. This new program is presented in Section 4. The program is expected to have impact on education as well as on future research directions. Our computational facilities have been expanded considerably with the installation of a VAX-11/780 computer, see Section 5.

We want to thank our sponsors, The Swedish Board of Technical Development (STU), The Swedish Institute of Applied Mathematics (ITM), The Research Institute of National Defence (FOA), The Swedish Council for Planning and Coordination of Research (FRN), The Swedish Board for Energy Source Development (NE), The Swedish Wastewater Works Association (VAV), and Sydkraft AB for their support to our projects.

2. EDUCATION

The courses given in the MS program are the same as in the previous years. The following number of students have passed during 1980-81 and 1981-82:

	80-81	81-82
Linear systems	281	225
Automatic control for chemical engineers	22	18
Principles of automatic control	4	6
Nonlinear and sampled data systems	23	25
Systems engineering	22	16
Computers in control systems I	28	24
Computers in control systems II	76	41

Fortythree students have made their MS-dissertations in Automatic Control. A list of the MS-theses is given in Appendix C. A list of the PhD courses given are found in Appendix D. Two PhD-theses have been completed during the period.

Several members of the department have taken an active part in the planning of the new curriculum in computer engineering. Although this consumes considerable effort we believe the activity to be worthwhile because of its long range strategic importance for the Institute of Technology.

New teaching laboratories

The need for upgrading our teaching laboratories has been recognized for some time. During this period we have made major exploratory efforts towards new laboratories. The basic ideas is to introduce computer controlled systems in the basic courses and to develop a collection of small teaching processes. We have tried and evaluated a number of commercial processes and we have experimented with designs of our own. It is expected that the effort will result in new labs in a few years time.

Computer-controlled systems

A major step towards a new course have been taken. A preliminary version of a new text has been tried.

Computers in control systems II

This course has been drastically revised. The revision was strongly influenced by the LICS project in the Center for Industrial Computer Systems (CID). A substantial project based on LSI-11 computers have been introduced in the course. In the project three different groups work on local control, man-machine interaction, and computer-computer

communication. The projects are implemented on different
LSI-11 systems. In the final test the three projects are
interfaced to make a functioning distributed system. Each
subproject results in up to 1500 lines of source code. The
project provides unique opportunities to get experience of
implementation and testing of real-time programming. We
expect to give more emphasis on implementation issues in the
years to come.

Continued education

We have made a policy decision to be actively involved in
continued education. The reasons are to obtain good feedback
from practising engineers and stimulation of course
development. We have set a goal of running four courses per
year.

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3. RESEARCH

Wind turbine generators

A mathematical simulation model for a large horizontal axis wind turbine system has been developed. The model is intended for simulation of the synchronization of the wind turbine generator against the utility grid and the operation of the wind turbine system under different wind conditions and with different control algorithms.

Particular attention has been given to the modularization. The model is divided into subsystems to make it easy to modify the model and adapt it to systems of similar type. The interactive simulation package SIMNON has been used.

The model has been used in a simulation study of WTS-3. WTS-3 is a 3 MW wind turbine system which has been built near the city of Trelleborg, in southern Sweden, by Karlskronavarvet AB, Sweden and Hamilton Standard, a division of United Technologies Inc., USA. A 4 MW plant (WTS-4) of the same design is built in Medicine Bow, Wyoming, USA.

WTS-3 is currently (summer 1982) taken into operation. As the physical system did not exist at the start of the simulation project, the only validation so far has been made by simulation comparisons from runs made by the WTS-3 designers. However, during the full-scale testing period 1982-1985, system identification and model validation will be done.

Currently the control problem is studied. The purpose is to discuss and evaluate different control strategies.

The project is done in cooperation with Sydkraft AB, Malmö, Sweden.

4. CENTER FOR INDUSTRIAL COMPUTER SYSTEMS

The Center for Industrial Computer Systems (Centrum för Industriella Datorsystem - CID) is a joint effort between the departments of Automatic Control and Computer Engineering. It is supported by the Swedish Board for Technical Development (STU).

One of the goals of the center is to establish hardware and software knowledge and experience for implementation of industrial computer systems, and to serve as a basis for advanced development projects with the industry.

The current major activities are in the fields of

- computer architecture and special purpose hardware
- hardware implementation of real-time computations
- real-time software for control applications

There are also other activities in the center with the purpose of broadening the knowledge base and increasing contacts with industry. These activities take the form of seminars, conferences, feasibility studies and master thesis projects. Seminars and conferences are listed in Appendix E.

Software tools for implementation of control systems

This project is carried out at the Department of Automatic Control. The purpose is to develop a system for documentation, implementation and testing of computerized control systems. It should be based on the concepts and notations used in automatic control theory and oriented towards the implementor and the controlled system.

The design aims at control systems for large industrial plants, presently controlled by, for example, DDC-packages, microprocessor based decentralized controllers and PC-systems. In many cases the control of each individual component poses no problem. The problem is to handle the large amount of information about all the controllers.

One aid when dealing with large amount of information is graphical representation. High resolution color screens are, in fact, available for process operators at this kind of plants. However, there are poor tools for the implementor of the control systems.

The structure of a plant and its control system has served as a basis for the design of the implementation system. A mapping of this basic structure to a graphical representation has been constructed. Decomposition of a system is represented by block diagrams. Hierarchical decomposition corresponds to zooming of a particular block

in the block diagram. At the lowest level there is a need to express algorithms as ordinary statements as well as documentation in the form of pure text.

A program prototype is developed in Pascal at a Vax-11/780 with a color graphics system with 512x512 resolution.

Some smaller subprojects have also been carried out:

- Design and implementation of a prototype language, called REGULA.

- Pascal for PC-systems, implementation of code generator (master thesis).

- Alphanumeric video terminal with zoom (master thesis).

- Implementation of a real time kernel for Pascal on LSI-11.

5. LABORATORY

The Vax computer

A Vax-11/780 computer was installed in September 1980. The configuration at that time was a very small one: 0.5 Mb of main memory, 2 x 28 Mb of disk space and 8 terminal ports. Since then it has been upgraded considerably, and the configuration at present (September 1982) is:

        2.5 Mb of main memory
        256 Mb Winchester disk (Ampex Capricorn)
        2 x 28 Mb removable disk (DEC RK07)
        32 terminal ports
        Tape drive (Ampex)
        Adapters for Multibus and Q-bus.

The Multibus contains equipment for computer image handling (2 Matrox RGB-Graph and 1 Matrox VAF-512). The Q-bus contains A/D and D/A converters. The operating system is VAX/VMS version V3.0. There is also a Eunice programming system, which enables simulation of a Unix programming environment.

Microcomputers

An Apple II microcomputer with diskette drives and process interface has been bought. It will be used to demonstrate simple computer control in the basic undergraduate courses, and also to investigate very simple self-tuning controllers.

We have also got a Falcon microprocessor (DEC). It will be used to investigate the possibility of making "packaged" adaptive controllers. The programs will be written in Omsi Pascal and a modified version of the Real Time Kernel (see reports TFRT-7230 and TFRT-7231) will be used.

Other equipment

A number of small processes for lab exercises has been bought or made during the period:

- A tank process for level control.

- A process for demonstration of mixing control with possibilities for transport delay and reflux.

- The "Coupled Drive Apparatus" from Tecquipment Ltd, for demonstration of tension and speed control of e.g. a roll of paper in a press or a paper machine.

- A number of standard PID regulators to control these and other processes.

6. TRAVELS

Travels by the staff are listed in Appendix G.

During April 12-17, 1982, eighteen members of the department made a study tour to Holland. The following departments were visited:

    Eindhoven University of Technology, Eindhoven:
        Group Measurement and Control
        System and Control Engineering Group

    Philips, Eindhoven:
        Philips Research Lab
        Product Division Science and Industry
        Lighting Demonstration Centre

    Delft University of Technology, Delft:
        Laboratory for Mechanical Measurement and Control
        Department of Electrical Engineering
        Department of Biochemical Reactors

The purpose of the travel were to study the work of other similar research groups and to get new ideas for our research and education in Lund.

The travel is reported in TFRT-8037.

APPENDIX A - LIST OF PERSONNEL JULY 1980 TO JULY 1982

Professor

    Karl Johan Åström

University lecturers (Universitetslektorer)

    Gustaf Olsson
    Björn Wittenmark

Research assistant (Forskarassistent)

    Per Hagander (Docent)

Research engineers (Forskningsingenjörer)

    Leif Andersson
    Sten Bergman (PhD candidate)
    Hilding Elmqvist (PhD)
    Tommy Essebo (programmer)
    Per-Olof Gutman (PhD, teaching assistant 80-81)
    Tore Hägglund (PhD candidate, teaching assistant 80-81)
    Matz Lenells (PhD candidate)
    Carl Fredrik Mannerfelt (PhD, teaching assistant 80-81)
    Sven Erik Mattsson (PhD candidate)
    Ann-Britt Östberg
    Lars Pernebo (PhD), until Aug 1981
    Thomas Schönthal (programmer)
    Anders Wikström

Teaching assistants (Assistenter)

    Jan Peter Axelsson (PhD candidate)
    Rolf Johansson (PhD candidate)
    Bengt Mårtensson (PhD candidate)
    Lars Nielsen (PhD candidate)
    Lars Rundqwist (PhD candidate)
    Karl-Erik Årzén (PhD candidate)

PERSONNEL

Laboratory engineer (Laboratorieingenjör)

    Rolf Braun

Visiting scientists (Gästforskare)

    Dr Zhou Zhaoying (Sept 1979 - Oct 1981)
    Tsiaghua University, Peking, China

    Dr Jin Shaoning (Sept 1979 - Aug 1981)
    South China Institute of Technology, Canton, China

    Professor Ennu Rüstern (Sept 1980 - Jan 1981)
    Tallinn Technical University, Tallinn, USSR

    Professor Oliver Jacobs (Febr 1-28, 1982)
    Oxford University, England

    Professor H Elliot (April 5-27, 1982)
    University of Massachusetts, Amherst, USA

    Professor Mont Hubbard (May 11 - June 4, 1982)
    University of California, USA

Technical drawings (Tekniskt biträde)

    Britt-Marie Carlsson

Secretaries (Sekreterare)

    Eva Schildt
    Eva Dagnegård (part time)

Typist (Skrivhjälp)

    Agneta Tuszynski (part time)

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TFRT-5265   Stamoulis A, Moustakas T: Algoritmer för digi-
tala PID-regulatorer (Algorithms for PID-
controllers). Dec 1981.

TFRT-5266   Mårtensson B: Zeros of samples systems.
Jan 1982.

TFRT-5267   Kalliakmanis K, Tsanis E: Experimentell under-
sökning av blandningsprocess (Investigation of a
mixing process). Jan 1982.

TFRT-5268   Axelsson J P: Reglering av sackaroshalten vid
fermentation i en reaktor med kontinuerligt
flöde (Control of sucrose concentration in a
fermentor with continuous flow). Febr 1982.

TFRT-5269   Heder N, Speidel T: Förstudie av programmet
SLIRSIM (Prestudy av the program SLIRSIM). March
1982.

TFRT-5270   Andell L-A: Självinställande PID-regulator för
system med tidsfördröjning (A self-tuning
PID-controller for systems with time delay).
March 1982.

TFRT-5271   Sandin G, Wullt T: Experiment med datorstyrd
kännande robot (Experiments with a computer
controlled touch-sensing robot). Aug 1982.

TFRT-5272   Eriksson G, Molin B-A: Design of a digital motor
speed controller. May 1982.

TFRT-5273   Persson M: Mätning av banhastighet med korrela-
tionsteknik (Measurement of web speed using
correlation methods). June 1982.

TFRT-5274   Rundqwist L: Mathematical modelling for simula-
tion of an extruder. June 1982.

TFRT-5275   Bengtsson T: Realtidskärna för Motorolas MC
68000 mikroprocessor (Real-time kernel for
Motorola MC 68000 micro processor). June 1982.

TFRT-5276   Persson T: Högupplösande färggrafik för
operatörskommunikation (High-resolution colour
graphics in control systems). June 1982.

TFRT-5277   Lilja M: Quantum mechanics and non-linear
filtering. June 1982.

REPORTS OF MASTER THESES

TFRT-6011   Pernebo L: Master theses in automatic control
             1979/80. Oct 1980.

TFRT-6012   Pernebo L: Master theses in automatic control
             1980/81. Nov 1981.

INTERNAL REPORTS

TFRT-7195   Carlsson Y, Carping T, Nellgård L, Eiken J,
             Nilsson B, Larsson E, Odelius M, Wiberg P A:
             Projektarbeten i reglerteknik systemteknik,
             våren 1978. Sept 1980. (Projects in course 9E,
             spring 1978). Sept 1980.

TFRT-7196   Åström K J: Datorstyrda processreglersystem.
             Presentation för data- och elektronikkommitt n
             9.1.1979 (Computer control. Presentation for the
             governmental committee on computers and
             electronics Jan 9, 1979). Sept 1980.

TFRT-7197   Åström K J: Syntes av servosystem. (Synthesis of
             servo systems). Sept 1980.

TFRT-7198   Åström K J: Three lectures on modeling, identi-
             fication and adaptive control. Sept 1980.

TFRT-7199   Olsson G: Automatic control in wastewater
             treatment plants, invited plants. Sept 1980.

TFRT-7200   Wittenmark B, Bar-Shalom Y: Model validation
             from estimated closed loop performance. 5th IFAC
             on identification and system parameter
             estimation. Sept 1980.

TFRT-7201   Wittenmark B, Hagander P, Gustavsson I: STUPID -
             Implementation of a self-tuning PID-controller.
             June 1980.

TFRT-7202   Åström K J: Inledande laboration i samplade
             system. (Laboratory notes for course 9F). Sept
             1980.

TFRT-7203   Åström K J: Design principles for self-tuning
             regulators. Sept 1980.

TFRT-7204   Åström K J: Overhead slides for eight lectures
             on stochastic control and its applications. Sept
             1980.

TFRT-7205   Pernebo L: Numerical algorithms for polynomial
             matrix systems. Oct 1980.

TFRT-7206   Pernebo L: A command guide for a computer
             program for polynomial matrix systems. Oct 1980.

TFRT-7207   Gutman P O: How to run IDPAC on Lund University
             computing centre. Aug 1980.

TFRT-7208   Hägglund T: Use of instrumental variables in
             self-tuning regulators. Oct 1980.

TFRT-7209   Gustavsson I: Implementation of a self-tuning
             regulator for non-minimum phase systems on PDP
             11/03. Oct 1980.

TFRT-7210   Gutman P O: Controllers for bilinear systems.
             Aug 1980.

TFRT-7211   Gutman P O, Mannerfelt C F, Molander P: On the
             model reduction problem. Dec 1980.

TFRT-7212   Mannerfelt C F: Nonlinear amplitude
             stabilization of a discrete time oscillator. Dec
             1980.

TFRT-7213   Magnusson B, Löfgren M, Elmqvist H, Fernström I,
             Kruzera I, Schöntal T: REGULA - An interactive
             user oriented language for implementation of
             control systems. Febr 1981.

TFRT-7214   Åström K J: MORE STUPID. Sept 1981.

TFRT-7215   Nielsen L: Analysis of a pump servo system using
             sampled data identification and continuous time
             interpretation. Febr 1981.

TFRT-7216   Breidegard B, Hägglund T, Gutman P O, Nyqvist J:
             A multiprocessor DDC-package. Apr 1981.

TFRT-7217   Essebo T: Machine code generation for Simnon on
             VAX-11. May 1981.

TFRT-7218   de la Cour U, Gupta B, Källgren S, Larsson T,
             Lindholm B, Ulveland P: System för automatisk
             landning av flygplan. Projektarbete i
             systemteknik våren 1974. (A system for automatic
             landing of airplanes. Projects in course 9e,
             spring 1974). June 1981.

TFRT-7219   Flote A, Ingemansson U, Johansson G, Marat S,
             Obrant O, Oleskog G, Wolszczan J: Modellering
             och simulering av datorstyrd svarv.
             Projektarbete i systemteknik våren 1980
             (Modelling and simulation of a numerically
             lathe. Projects in course 9e spring 1980). June
             1981.

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REPORTS

TFRT-7220   Andersson I, Bolmsjö G, Dimitric D, Johnsson S,
             Kristensson T, Laurell S, Löfstedt J, Morinder
             L, Schierwagen T, Wemmert B, Wong K S:
             Modellbygge med simulering på värmepumpsanlägg-
             ning i Skurup. Projektarbete i systemteknik
             våren 1981 (Modelling and simulation of a heat
             pump system at Skurup. Projects in course 9e
             spring 1981). June 1981.

TFRT-7221   Bengtsson T, Bengtsson M, Bergström M, Hedar N,
             Lie M, Christiansen T, Moustakas T, Skeppe H,
             Lundgren B, Karavas D: Simulering av hjälpmatar-
             vattensystemet till Oskarshamn 1. Projektarbete
             i systemteknik våren 1981 (Simulation of
             auxiliary feedwater system at the Oskarshamn
             nuclear power plant. Projects in course 9E
             spring 1981). June 1981.

TFRT-7222   Åström K J: Ship steering. A test example for
             robust regulator design. June 1981.

TFRT-7223   Zhao-Ying Z, Åström K J: Polynomial factor-
             ization using recursive formulas for complex
             integrals. June 1981.

TFRT-7224   Hägglund T: A PID tuner based on phase margin
             specification. Sept 1981.

TFRT-7225   Zhao-Ying Z, Åström K J: Regulator syntheses
             based on polynomial manipulation. June 1981.

TFRT-7226   Zhao-Ying Z, Åström K J: A microcomputer
             implementation of LQG self-tuner. July 1981.

TFRT-7227   Bergman S, Mattsson S E, Östberg A-B: A modular
             simulation model for a wind turbine system. Sept
             1981.

TFRT-7228   Mattson S E: ADA in control applications - a
             case study. Sept 1981.

TFRT-7229   Åström K J, Zhao-Ying Z: Self-tuners with
             automatic adjustment of the sampling period for
             processes with time delays. Aug 1981.

TFRT-7230   Elmqvist H, Mattsson S E: Implementation of
             Basic primitives for concurrent programming in
             Pascal. Aug 1981.

TFRT-7231   Elmqvist Hilding, Mattsson S E: A real-time
             kernel for Pascal. Aug 1981.

TFRT-7232   Nielsen L, Wennerström H, Hagander P: Thermo
             dynamics and control of the oxidative phosphor-
             ylation in mitochondria. An investigation of the

oxidative phosphorylation in mitochondria. An
investigation of the consequences of the
chemiosmotic theory. Jan 1982.

TFRT-7233   Johansson R: Parametric models of linear
multivariable systems for adaptive controllers.
Febr 1982.

TFRT-7234   Tengvall F: Rendezvous primitives for intertask
communication on VAX/VMS. March 1982.

TFRT-7235   Hultman B and Olsson G: Static analysis of a
nitrifying activated sludge process. July 1980.

TFRT-7236   Olsson G, Fukuzaki T, Lin C, Doi K and Frogner
B: Predictions of power and thermal margin
changes for rod withdrawals in boiling water
reactors. Jan 1981.

TFRT-7237   Andrews J F, Olsson G, Hill R: ASCL - An
activated sludge process control language. Sept
1981.

TFRT-7238   Sternby J: Självinställande nivåreglering i
massakokeri (Selftuning level control in a pulp
factory). March 1982.

TFRT-7239   Mattsson S E: Development of a modular
simulation model for a wind turbine system.
March 1982.

TFRT-7240   Polak E, Åström K J, Mayne D Q: Interoptdyn
SISO: A tutorial. March 1982.

TFRT-7241   Åström K J: Parameterization of special digital
control algorithm. May 1982.

TFRT-7242   Hägglund T: Adaptive control with fault
detection. June 1982.

TFRT-7243   Mannerfelt C F: A note on the Smith predictor.
June 1982.

TFRT-7244   Åström K J, Helmersson A: Dual control of a low
order system. June 1982.

TFRT-7245   Åström K J: Adaptiv reglering (Adaptive
control). June 1982.

TRAVEL REPORTS

TFRT-8029   Åström K J: Besök på University of Singapore.
(Visit to University of Singapore). Sept 1980.

REPORTS

TFRT-8030 Gutman P O: Studieresa till västsvenska företag,
1979. (Visit to industries in western Sweden
1979). Sept 1980.

TFRT-8031 Åström K J: Visit to China April 1980. Sept
1980.

TFRT-8032 Åström K J: Processreglering i kemiindustrin -
Intryck från en kongress arrangerad av
Engineering Foundation januari 1981. (Process
control in the chemical industry - Impressions
from a conference by Engineering Foundation,
Januari 1981). June 1981.

TFRT-8033 Pernebo L: Workshop on feedback and synthesis of
linear systems, Bielefeld, Germany. Nov 1981.

TFRT-8034 Nielsen L: Studieresa 9-23/6 1981 till
forskningscentra inom bildbehandling i USA
(Visit to image processing research centers in
USA 9-23/6 1981). Feb 1982.

TFRT-8035 Åström K J: Plenary lecture at the 8th IFAC
World Congress, August 24-28, 1981. May 1982.

TFRT-8036 Elmqvist H: Travel report USA 1981: Man-machine
interaction. May 1982.

TFRT-8037 Arzén K-E: Studieresa till Holland 12-17/4 1982
(Visit to The Netherlands 12-17/4 1982). July
1982.

APPENDIX D - COURSES AND SEMINARS AT THE DEPARTMENT

Undergraduate courses, graduate courses, seminars as well as external courses, given at the department during the year, are summarized here. They are given both by the staff at the department and by invited lecturers.

Undergraduate courses

Linear systems (Reglerteknik AK)
Automatic control for chemical engineers (Reglerteknik MK)
Principles of automatic control (Reglerteknikens grunder)
Nonlinear and sampled data systems (Reglerteknik FK)
Systems engineering (Systemteknik)
Computers in control systems I (Datorer i reglerteknik I)
Computers in control systems II (Datorer i reglerteknik II)

PhD Courses

The following courses have been given:

Adaptive control   (K J Åström)
Identification   (P Hagander)
Algebraic design methods   (L Pernebo)
Linear systems   (P Hagander)
Control of nuclear reactors   (S Bergman)
Analog techniques for implementing regulators   (K J Åström)
Numerical methods in control   (P Hagander)

Seminars

1980

Aug 14, 19   Prof A Willsky (MIT): Issues in the
               implementation of control compensators.

Aug 20, 22,   Prof A Willsky (MIT): Abrupt changes in signals
26   and systems.

Sept 3   M Grimble (Sheffield Polytechnic): Selection of
               Q and R weighting matrices using results from
               multivariable root loci.

Sept 5   P Dybjer (Lund): Formell specifikation av
               program och programmeringsspråk - ett hjälpmedel
               att övervinna mjukvarukrisen (Formal
               specification of program and programming
               language - a mean to overcome the software
               crisis).

COURSES & SEMINARS

Sept 8   J van Schuppen (Amsterdam): The stochastic
            filtering problem for point processes.

Sept 10   K J Åström: Piecewise deterministic functions.

Sept 16   T Bohlin (KTH), A Marlevi (LME): Synkronisering
            av okända telekommunikationsnät genom
            decentraliserad reglering av klockfrekvenser
            (Decentralized control of the oscillators in
            unknown communication networks).

Sept 22   Prof C Moler (Albuquerque): Matlab.

Oct 12   Prof W Schaufelberger (ETH Zurich): Experiences
            with project-oriented and group-teaching courses
            in a graduate control program.

Oct 13   Prof W Schaufelberger: Industrial applications
            of adaptive control in Switzerland.

Nov 4   G Bengtsson (ASEA): Framtidsvyer (Trends in
            control).

Nov 28   A Rault (France): Process control - Idcom.

Dec 9   L Dahlström (ASEA): Industriella tillämpningar
            av fiberoptik och seende datorer för industriell
            automation (Industrial application of
            fiberoptics and vision in industrial control
            computers).

Dec 22   B Leden (Mefos): Framtida värmeforskning (Future
            research in heat technics).

1981

Jan 12   T Westerlund (Åbo Akademi): Tillämpning av
            stokastisk reglerteori vid cementframställning
            (Application of stochastic control theory in
            cement productions).

Jan 14   R Syding (ASEA): Tillståndsdiagnostik (State
            diagnostics).

Jan 21   C Ovr n (ASEA): Nya givarprinciper -
            fiberoptiska givare (New sensor concepts -
            fiberoptic sensors).

Feb 25   G Martins (ASEA): Framtida användning av robotar
            (Future use of robots).

March 26   Prof J Zaborsky (Washington univ): Local
            feedback stabilization of large interconnected
            power systems in emergencies.

COURSES & SEMINARS

March 30	Visit by engineering students from Grenoble.
April 29	I Rydahl & B Sandin (Asea Atom): Designfilosofi vid reglering av kärnkraftverk (Design philosophy in the control of nuclear power plants).
May 8	B Tyreus (Bofors Nobel Kemi): Multivariable control - An industrial view.
Aug 11	Prof E Angel (Univ of Mexico): Image processing, an overview.
Aug 12	Prof E Angel: Image models.
Aug 13	Prof E Angel: Half tones and image coding.
Aug 14	Prof E Angel: Texture analysis and tissue characterization.
Sept 4	D J Bell (University of Manchester): Von Zeipel's perturbation procedure for optimal control.
Sept 9	J Taylor (General Electric): Nonlinear oscillations.
Sept 10	J Taylor: Covariance analysis of nonlinear systems.
Sept 15	Visit by prof Lin Zi-zhi and colleagues from Sheynang Institute of Automation, China.
Sept 30	C F Mannerfelt: Robusta regulatorer (Robust regulators).
Oct 6	P O Gutman: Linjärprogrammeringsregulatorn (The LP-regulator).
Oct 16	C F Mannerfelt: A simple self-tuner.
Oct 20	A Rault (Adersa/Gerbos): Fault detection.
Oct 27	H Elmqvist & T Essebo: LICS - ett datorhjälp-medel för implementering av reglersystem (LICS - A tool for implementation of control systems).
Oct 30	G Bengtsson (Asea): Avancerad reglerteori i praktiken (Advanced control in industrial practice).
Nov 4	K J Aström: The Ziegler-Nichols selftuner.
Nov 4	T Hägglund: The phase margine selftuner.

Nov 11   S E Mattsson: ADA för implementering av regler-
            system (Implementation of control laws in ADA).

Nov 12   H Boman (Skandiakoncernen): Försök att tillämpa
            reglerteori inom försäkringsrörelsen (Insurance
            business as a control problem).

Nov 13   K J Aström: Theory and application of adaptive
            control.

Nov 18   S Bergman, S E Mattsson, A B Östberg: A modular
            simulation model for a wind turbine system.

Dec 3   H Elmqvist: Programming environments - a travel
            in USA.

Dec 16   H Elmqvist: Dymola - hur gör man? (Dymola - how
            to use it).

1982

Jan 8   R Johansson: Flervariabla adaptiva regulatorer
            (Multivariable adaptive control).

Jan 15   L Andersson: Hur skall en LOGIN-fil se ut? (What
            does a LOGIN-file look like?).

Jan 22   G Olsson & K J Aström: Decision and Control
            Conference 1981.

Jan 27   M Fjeld (SINTEF): Diskussion om adaptiv
            reglering (Discussion of adaptive control).

Feb 2   Prof O L R Jacobs (Oxford University): On-line
            computer control of pH in an industrial process.

Feb 3   Prof O L R Jacobs: Feedback control of post-
            operative pain.

Feb 5   Prof O L R Jacobs: Estimation through scalar
            non-linear output.

Feb 9   P O Gutman: A new design for constrained
            controllers for linear systems.

Feb 11   Prof O L R Jacobs: On the significance of
            controller dynamics.

March 5   Prof L Ljung (LiTH): Adaptiv reglering baserad
            på kriterieminimering (Adaptive control based on
            criteria minimization).

March 12   J Holst (Imsor/LTH): Reglerteknik och Imsor
            (Automatic Control and Imsor).

COURSES & SEMINARS

March 18	Prof H Koivo (Tampere Univ): Tuning of multivariable PI-controllers for unknown linear systems.
April 6	C van Loan (Cornell Univ): Riccati equation solution.
April 28	Visit by P Hibbard from Carnegie-Mellon University.
April 28	Visit from Ericsson, Mölndal: Presentation av aktiviteter vid LME. Realtidsprogrammering. (Activities at LME. Real-time programming.)
May 18	Prof M Hubbard (Univ of California): Dynamics in biomechanical systems. Application to locomotion and sportmechanics.
May 19	Prof M Hubbard: Optimum vehicle suspension minimizing RMS rattlespace, sprung-mass acceleration and jerk.
May 19	K Sh Zigangirov (IPPI, Moscow): Some problems of information theory connected with control theory.
May 24	Prof M Hubbard: Estimation of feedstream concentrations in cement raw material blending.
May 24	H Elmqvist: Programsystem för implementering, dokumentation och testning av reglersystem (A program for implementation, documentation and testing of control systems).
June 1	J E Larsson, H Franzon: Spelprogram (Computer chess).
June 4	A Willsky (MIT): Reconstruction of 2D fields from line integrals based on the detection and estimation of objects.
June 14	T Wiberg (Umeå): Programmeringsmiljö (Programming environments).
June 18	Visit by S Kahne (Case Western Reserve Univ, Ohio). Discussions on collaboration NSF - STU.

External courses

Sept 23-25, 1980,
Workshop on numerical methods in automatic control:

1. A Laub (Univ of Southern Calif): Survey of computational methods in control theory.

2. V Klema (MIT, USA): Mathematical software for control
    and estimation theory.

3. M Denham (Kingston Polytechnic, UK): UK SRC control
    algorithm library.

4. D Boley & G H Golub (Stanford univ): Block Lanczos and
    control theory.

5. M Denham: The determination of large scale systems
    structures using principal component analysis.

6. P van Dooren (Philips res lab, Brussels): A generalized
    eigenvalue approach for solving riccati equations.

7. V Strejc (Czechoslovak Academy of Science, Prague):
    Square root filtering and UD-decomposition.

8. C B Moler (Univ of New Mexico): MATLAB - An interactive
    matrix laboratory.

9. F Cellier (ETH, Zurich): On the numerical integration of
    discontinuous ordinary differential equations -
    simulations and real-time applications.

10. C W Gear (Univ of Illinois): Oscillating problems and
    limit cycles (tentative title).

11. M Sorine (INRIA, France): Numerical solution of Riccati
    and Chandrasekhar equations arising in optimal control
    of distributed parameter systems.

12. N Nichols (Univ of Reading, UK): Application of
    numerical boundary value problems in optimal control.

13. S A Gustafsson (The Royal Inst of Technology,
    Stockholm): Numerical treatment of parabolic boundary-
    value control problem by means of semi-infinite
    programming.

14. R Gorez (Univ of Louvain, Belgium): Some features of
    Chandrasekhar equations and orthogonal transformation
    techniques in optimal control.

15. A Wierzbicki (IIASA, Austria): Trajectory optimization -
    theoretical background and practical motivations for
    infinite-dimensional objectives in dynamical optimiza-
    tion and control.

16. B Asselmeyer (Technische Hochschule, Darmstadt):
    Comparison of several optimization methods not requiring
    exact one-dimensional searches - Numerical experience.

17. E Polak, Univ of California Berkley, USA): Algorithms
    for control systems design involving singular value

inequalities.

18. E Spedicato (Univ of Bergamo, Italy): Use of slack
    variables in nonlinear programming.

19. P Zencke (Univ of Bonn): A self-starting algorithm for
    the identification of positive exponential decay
    components by minimization of the Chebyshev error.

20. A Ruhe (Univ of Umeå): Fitting emperical data by
    positive sums of exponentials.

21. V Kucera (Chechoslovak Academy of Science, Prague):
    Control systems design using polynomial equations.
    Numerical aspects.

22. L Pernebo: Numerical problems in multivariable synthesis
    using the polynomial approach.

23. J Edmunds (Cambridge Univ): A frequency response
    algorithm to calculate precompensators which optimise
    the closed loop response of a multivariable system.

24. K Zeiske (Ruhr Univ Bochum): Routh-criterion for
    obtaining the roots of polynomials.

25. J Wieslander (Stora Kopparberg AB): A sequence of
    programs for control systems analysis and design.

26. A Barraud (Laboratoire D'Automatique de Grenoble):
    Autopac a robust software for automatic control
    purposes.

27. H Elmqvist: A language for dynamical models based on
    general equations.

28. C Suleyman and A Barraud (Laboratoire D'Automatique de
    Grenoble): ISER-CSO an interactive system for education
    and research in control.

29. R Gorez (Univ of Louvain, Belgium): PAAS and SIMUL,
    conversational programs for educational purposes in
    control systems analysis.

30. H C Lammers and A Kraak (Delft Univ of Technology):
    STUPID - an in-line computer-aided control/design
    package.

Nov 5-7, 1980,
Course in control theory for ASEA. K J Aström, B Wittenmark
and P Hagander.
Contents:

1. Presentation.

2. Linear continuous time systems.

3. Sampled systems.

4. Stochastic systems.

5. Future trends in control.

6. Laboratory - Simnon.

7. Perspective - Modelbuilding, identification, adaptive control.

March 16 - May 18, 1982,
Course in Simnon for teachers at Lund Institute of Technology. B Wittenmark, P O Gutman, S E Mattsson, G Olsson.
Contents:

1. Simulation of dynamic systems - an overview.

2. Simnon - how to do.

3. A case study - simulation of a wind power plant.

4. Experiences, problems and solution. Course evaluation.

5. Exercises.

March 22-26, 1982,
Review course in control theory for the power industry. K J Aström, G Olsson, S Bergman, M Lenells, L Andersson, P O Gutman, C F Mannerfelt, B Wittenmark, P Hagander.
Contents:

1. Simple regulators and introductory computer programming.

2. Conventional control systems.

3. Process models and simulation.

4. Identification, specifications and advanced control forms.

5. Trends and computer control.

6. Programming and simulation exercises.

May 4-6, 1982,
Course in simulation of dynamical systems for engineers in industry. B Wittenmark, R Johansson, C F Mannerfelt, P O Gutman, S E Mattsson, G Olsson, H Elmqvist.

COURSES & SEMINARS

Contents:

1. Simulation of dynamical systems, principles and methods.

2. Simnon - an interactive simulation program.

3. Examples of the use of simulation.

4. Simnon - how to do.

5. Case study - simulation of a wind power plant.

6. Simulation languages - an overview.

7. Dymola - a structured model language for continuous systems.

8. Computer exercises.

May 25-27, 1982,
Course in digital control for engineers in industry.
B Wittenmark, G Olsson, P O Gutman, M Lenells, T Hägglund, P Hagander, C F Mannerfelt, H Elmqvist.
Contents:

1. Computers as controllers.

2. Sampling.

3. Analysis of discrete-time systems.

4. The design problem. Translation of continuous-time controllers to digital form.

5. Controllers based on state-space models.

6. Controllers based on external models.

7. Adaptive control.

8. The real time programming problem.

9. A direct digital control program.

10. Laboratory exercises

June 2-4, 1982,
Repetition of Course in digital control for engineers in industry, same contents as above.

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APPENDIX E - SEMINARS ARRANGED BY CID

Seminars arranged by Center for Industrial Computer Systems (CID, Centrum för Industriella Datorsystem) are summarized here. Read about CID in Section 4.

<u>1980</u>

Sept 15 S Fogelström (Teleplan, Solna): De nya 16-bitars mikrodatorerna (The new micro processors with 16 bits).

Sept 22 H Lunell (LiTH): Pascal - ett välstrukturerat programspråk för mikrodatorer (Pascal - A well structured programming language for micro processors).

Sept 29 H Elmqvist (LTH): Översikt över hjälpmedel för implementering av reglersystem (Tools for implementation of control systems).

Oct 6 G Sigfridsson & C Ahlerup (Satt-Elektronlund, Malmö): PC-system (Programmable controllers).

Oct 13 H Elmqvist & S E Mattsson (LTH): Programmering av parallella aktiviteter (Concurrent programming).

Oct 20 C Cöster (Kockumation, Malmö): In- och utmatning till datorer med mänskligt tal (Computer input and output with human speech).

Oct 27 J Agerberg (FOA) & S E Mattsson: Ada - det nya realtidsspråket (Ada - The new real time programming language).

Nov 3 A Rajnak (CTH): Smådatorer i mätsystem (Measurement systems with small computers).

Nov 10 A Jacobsson & T Hagström (Saab-Scania): Framtagande av mikrodatorbaserade enloops-regulatorer (Development of a micro processor based one-loop controller).

Nov 17 M Cedervall (LTH): Programmerbara sekvensnät och bit-slice teknik (Programmable logic and bit-slice technique).

Nov 24 K Hassel (Teleplan, Solna): Felsökning i mikrodatorsystem (Debugging of micro computer systems).

Dec 1 B Svensson & U Carlsson (Sattco, Solna):

CID SEMINARS

Förarbetade kundkretsar (Semi custom designed
LSI-circuits).

1981

March 9   J Olofsson (MoDo Chemetics): Realtids-Basic -
            Ett interaktivt språk för processtyrning
            (Real-time Basic - An interactive language for
            process control).

March 16   B A Bergvall & K Andersson (Husqvarna AB):
            Introduktion av mikrodatorer i en traditionellt
            helmekanisk produkt (Introduction of micro
            processors in a traditionally completely
            mechanical product).

March 23   R Bernemyr (Televerkets Centralförvaltning):
            Digital kommunikation genom optiska fibrer
            (Digital communication using optical fibres).

March 30   H Bäckman (Datahuset, Täby) and B Åkerlind
            (Nordisk Elektronik AB, Stockholm):
            Kort-datorsystem (Modular micro computer
            systems).

Apr 6   J E Lundström (ASEA): Färgbildspresentation i
            processdatorsystem (Color graphics in process
            control systems).

Apr 13   A Eckerström (Televerkets Centralförvaltning):
            Datornät och datorkommunikation (Computer
            networks and computer communication).

May 25   Seminars on 'personal computers for technical
            applications':

            1. K Johansson (Frontec): Hårdvara i smådatorer
            (Hardware for personal computers).

            2. S Nilsson (Teleplan): Mjukvara i smådatorer
            (Software for personal computers).

            3. L Philipsson (Computer Engineering, LTH):
            Forskning och utveckling (Research and trends).

            4. R Brodin (Hobbydata): Tillbehör för
            smådatorer (Accessoires for personal computers).

            5. S O Carlberg (Luxor TV AB): Tillämpningar
            (Applications).

            6. Discussions, exhibition.

CID SEMINARS

1982

April 19-21 Prof H Elliott: Seminars on 'Image segmentation algorithms for engineering problems in computer vision':

1. Overview and introduction.

2. Boundary oriented image segmentation.

3. Region oriented image segmentation.

April 19-22 Prof H Elliott (Colorado State Univ): Seminars about 'Discrete multivariable adaptive control':

1. The pole-placement approach.

2. Discrete multivariable adaptive control II.

3. Discrete multivariable adaptive control III.

April 26 Seminars about 'scientific personal computers':

1. L Philipson (Computer Engineering, LTH): Inledning och bakgrund (Introduction and background).

2. P Hibbard (Carnegie-Mellon University): SPICE - An experiment in personal computing.

3. K J Åström: Vetenskapliga persondatorer vid amerikanska universitet - intryck från en studieresa våren 1982 (Scientific personal computers at universities in the USA - impressions from a visit, spring 1982).

4. K Skog (University of Tromsö): Dokumentproduktion and fontverktyg (Document production and font tools).

5. L Kahn (STU): Vetenskapliga persondatorer för ovetenskapligt arbete - användning av persondatorer i kontorsmiljö (Scientific personal computers for nonscientific work - use in office environments).

6. H Elmqvist: Persondatorer med extremt snabb färggrafik och speciella grafiska processorer - presentation av ett projekt vid Stanford University (Scientific personal computers with extremely fast color graphics and special

graphic processors - presentation of a project at Stanford University).

7. L Philipson and M Taube (Computer Engineering LTH): Interaktiv konstruktion av högintegrerade kretsar, exempel på konvertering av programvara till vetenskaplig persondator (Interactive construction of LSI-circuits, example of conversion of software for scientific personal computers).

8. Panel: Trends for scientific personal computers.

May 10-11   Seminar series about decentralised process computer systems: Fault-tolerant distributed computer control systems including colour screen control panels and higher level programming systems. Prof Dr M Syrbe, Dr H Steusloff, Dipl-ing D Heger (Fraunhofer-Institut fur Informations- und Datenverarbeitung).

1. Requirements and technology trends promoting control computer systems architecture.

2. CAE (Computer Aided Engineering) of control computer systems.

3. Basic principles of program design.

4. Languages for real-time programming, Pearl.

5. Pearl, multicomputer-pearl.

6. Supporting systems programs, operating systems, test systems.

7. Basic principles and modelling of man-machine communication.

8. EAF: An advanced input/output color screen display system.

9. Basic principles of local area networks (LAN) - (System types, performance analysis).

10. LAN in the RDC-system (distributed computer control system of IITB). Further extensions to open networks (THYNET).

11. Basic principles and trends towards modular self-testing systems.

12. RDC-devices and EAF-devices, the hardware of two realized systems.

13. Results of 5 RDC-systems, considering fault tolerance and performance during 3 years.

14. Application systems: application of RDC, EAF and multicomputer pearl on soaking pit furnaces, industrial data communication system, Robots.

15. Results of the application of multi-computer Pearl over the life cycle of the programs.

16. Linked method base system and real-time database for process automation.

APPENDIX F - LECTURES BY THE STAFF

<u>1980</u>

Aug 14   Olsson G: Some new results on activated sludge
                control based on dissolved oxygen profiles.
                Paper presented at the Joint Automatic Control
                Conference, San Francisco, USA.

Aug 15   Sternby J: Extremum control system - An area for
                adaptive control? Joint Automatic Control
                Conference, San Francisco, USA.

Sept 4   Åström K J: Styrsystem inom processindustrin -
                Framtidsutsikter (Control systems in the process
                industry - an outlook). Mo och Domsjö,
                Örnsköldsvik, Sweden.

Sept 4   Åström K J: Reglerteknikens utveckling (The
                progress of automatic control). Mo och Domsjö,
                Örnsköldsvik, Sweden.

Sept 30   Åström K J: Robustness of a design method based
                on an assignment of poles and zeros, VDE/VDI,
                Working group on advanced control algorithms in
                industry. Interlaaken, Zurich, Zwitzerland.

Oct 7   Åström K J: Datorstyrd processreglering.
                Computer process control. Statsföretag,
                Stockholm, Sweden.

Oct 10   Olsson G: Wastewater treatment control, modeling
                and identification in wastewater treatment. 6
                lectures at EMA Inc, St Paul, Minnesota, USA.

Oct 15   Åström K J: Validation of control systems
                models. Task Force Meeting on Model Validity
                Credibility, IIASA, Vienna, Austria.

Oct 24   Olsson G: Some advances in control of wastewater
                treatment system control. Dept of Civil
                Engineering, Univ of Houston, Houston, Texas,
                USA.

Nov 21   Olsson G: Process control in activated sludge
                systems - experiences from Sweden. Department of
                Sanitary Engineering, Univ of California,
                Berkeley, USA

Nov-Dec   Olsson G: Self-tuning regulators, principles and
                applications. 5 lectures at Systems Control Inc,
                Palo Alto, California, USA.

LECTURES

Dec 5   Wittenmark B: Design principles for digital
          controllers and their application to self-tuning
          controllers. Univ of Cennecticut, Storrs, USA.

Dec 9   Wittenmark B: Design principles of self-tuning
          regulators. Some applications of adaptive
          control. Workshop on stochastic adaptive control
          at the 19th IEEE Conf Decision and Control,
          Albuquerque, New Mexico, USA.

Dec 11   Åström K J: Direct methods for non-minimum phase
          systems. 19th IEEE Conf Decision and Control,
          Albuquerque, USA.

Dec 11   Åström K J: Zeros of sampled systems. 19th IEEE
          Conf Decision and Control, Albuquerque, USA.

Dec 12   Åström K J: Theory of sampled systems. 19th IEEE
          Conf Decision and Control, Albuquerque, USA.

Dec 15   Åström K J: What happens to the zeros of a
          system when it is sampled. Univ of California,
          Berkeley.

Dec 15   Wittenmark B: Design principles for and
          applications of self-tuning regulators. Systems
          Control Inc, Palo Alto, USA.

Dec 16   Åström K J: Perspective on interactive software
          for computer aided modeling and design of
          control systems. 20th IEEE Conference on
          Decision and Control, San Diego, USA.

1981

Jan 16   Åström K J: Adaptive regulators for steering of
          ships. Univ of Gainsville, Florida.

Jan 21   Åström K J: Sensitivity of control systems
          design to modeling errors. Engineering
          foundation workshop on process control in a
          chemical industry, Florida.

Jan 29   Åström K J: Computer aided design. Honeywell
          Research division, Minneapolis, USA.

Feb 23   Olsson G: Computer applications in the
          wastewater treatment industry. Dept of
          Electrical Engineering, Univ of Houston, Texas,
          USA.

Feb 25   Olsson G: Modeling, estimation and control of
          activated sludge plants. Wastewater Technology
          Centre, Canada Centre for Inland Waters,

LECTURES

Burlington, Ontario, Canada.

Feb 26   Olsson G: Software and hardware for on-line
          computers - applications in the wastewater
          industry. Greeley and Hansen Engineers, Chicago,
          Illinois, USA.

March 4   Hagander P: Monte Carlo and flowsystems
          cellcycle simulation, a comparison.
          International workshop on biomathematics and
          cell kinetics, Asilomar, California, USA.

March 5   Olsson G: Computer control in treatment
          processes. California section of Water Pollution
          Control Federation, Richmond, California, USA.

March 9   Hagander P: Mathematical analysis of cancer cell
          dynamics. Univ of Colorado, School of Medicine,
          Dept of Biometrics, Denver, Colorado, USA.

March 10 Åström K J: Adaptiv reglering (Adaptive
          control). Helsingfors, Finland.

March 19 Wittenmark B: Adaptive and self-tuning control
          systems, NTH, Trondheim, Norway.

Apr 2-3   Olsson G: Dynamical modeling, estimation and
          control of activated sludge systems.
          Weyerhaeuser Technical Centre, Weyerhaeuser
          Company, Tacoma, Washington, USA.

Apr 23   Åström K J: Funderingar kring reglerteknikens
          teori och praktik (Thoughts on theory and
          practice in automatic control). Åbo academy,
          Åbo, Finland.

May 13   Wittenmark B: Självinställande regulatorer
          (Self-tuning regulators). Asea, Ludvika, Sweden.

May 13   Åström K J: Adaptive control. Lecture at the
          Optimization Days, Montreal, Canada.

May 19   Åström K J: The parameterization problem in
          adaptive control. Workshop on System Geometry,
          System Identification and Parameter Estimation,
          Henderson House, Mass, USA.

May 20   Åström K J: Status of computer aided control
          system design for modeling and identification.
          GE-RPI-NSF Workshop on Control Design,
          Schenectady, NY, USA.

May 21   Gutman P O: Non-linear regulators. Dept of
          Industrial Electronics, Luleå, Sweden.

LECTURES

May 27   Åström K J: Adaptive autopilots for ship
                steering. 2nd Yale Workshop on Applications of
                Adaptive Control, Yale, New Haven.

June 1 -   Åström K J: 12 lectures on Adaptive Control.
- July 10   ETH, Zurich, Switzerland.

June 3   Hagander P: Analys och simulering av
                cellcykelkinetik (Analysis and simulation of
                cellcycle kinetics). Dept of Automatic Control,
                University of Uppsala, Sweden.

June 22   Olsson G: Dissolved oxygen control in the
                activated sludge process. Paper presented at the
                Int Association on Water Pollution Research
                (IAWPR). Int workshop on practical experiences
                of control and automation in wastewater
                treatment and water resources management,
                Munich, West Germany.

June 25   Olsson G: Control and automation in wastewater
                treatment - advances, challenges and
                disappointments. Invited final workshop address,
                IAWPR workshop, Munich, West Germany.

June 30   Åström K J: Thoughts on theory and practice of
                automatic control. Swiss Society of Automation,
                Switzerland.

Aug 18   Olsson G: Control and estimation methods -
                Applications to wastewater treatment control.
                Systems Development Laboratory, Hitachi,
                Kawasaki City, Japan.

Aug 27   Olsson G: Estimation of loading changes for the
                nitrifying activated sludge process. Paper
                presented at the 8th IFAC World Congress, Kyoto,
                Japan.

Aug 27   Åström K J: Theory and applications of adaptive
                control. Plenary lecture 8th IFAC World
                Congress, Kyoto, Japan.

Sept 2   Åström K J: Linear quadratic Gaussian control.
                Arab School of Science and Technology, Bloudan,
                Syria.

Sept 5   Åström K J: Adaptive control. Arab School of
                Science and Technology, Bloudan, Syria.

Sept 24   Olsson G: Operational and control challenges in
                biological wastewater treatment. Elmia Int Conf
                on Air and Water Conservation, Jönköping,
                Sweden.

LECTURES

Oct 5   Wittenmark B: Signalbehandling och regleralgo-
             ritmer (Sampled data systems and digital
             controllers). STF course Mikrodatorbaserade
             processreglersystem (Microcomputer based process
             control), Linköping, Sweden.

Nov 16   Mattsson S E: Ada i reglersystem - en tillämp-
             ningsstudie (Ada in control applications - A
             case study). The Swedish Institute of National
             Defense (FOA), Stockholm, Sweden.

Nov 16   Elmqvist H: A programming environment for
             implementation of control systems. IBM Research
             Laboratory, San José, USA.

Nov 18   Elmqvist H: A programming environment for
             implementation of control systems. Xerox Palo
             Alto Research Center (PARC), Palo Alto, USA.

Nov 24   Elmqvist H: Dymola - A structured model language
             for continuous systems and a programming
             environment for implementation of control
             systems. Rensselaer Polytechnic Institute, Troy,
             USA.

Dec 8   Olsson G: Applications of computer control
             systems to wastewater treatment. Department of
             Environmental Science and Engineering, Rice
             University, Houston, Texas.

Dec 13   Wittenmark B: Processtyrning med datorer
             (Process control using computers). In the
             conference 'Datasystem för Produktions- och
             Processtyrning' arranged by Svenska
             Dataföreningen, Kungälv, Sweden.

Dec 18   Åström K J: Perspective on interactive software
             for computer aided modeling and design of
             control systems. 20th IEEE Conf Decision and
             Control, San Diego, California, USA.

Dec 18   Olsson G: An approach to air-fuel ratio control
             for automobile engines using self-tuning
             regulators. 20th IEEE Conf Decision and Control,
             San Diego, California, USA.

1982

March 9   Olsson G: Dynamics and control in biological
             wastewater treatment. Dept of Chemical
             Engineering, Institute of Technology, Lyngby,
             Denmark.

March 9   Olsson G: Air-fuel ratio control in internal

combustion engines. Dept of Chemical
Engineering, Institute of Technology, Lyngby,
Denmark.

April 19   Wittenmark B: Signalbehandling och regleralgo-
ritmer (Sampled data systems and digital
controllers). STF course Mikrodatorbaserade
processreglersystem (Microcomputer based process
control), Linköping, Sweden.

APPENDIX G - TRAVELS

Karl Johan Åström participated in the VDE/VDI Working Group on robust control in Interlaken in Sept 1980. He participated in the Decision and Control Conference in Albuquerque in December. In connection with this he also visited University of California, Berkeley. Åström participated in the second conference on Chemical Process Control in Sea Island, Georgia, in Jan 1981. In connection with this he also visited University of Florida and the Research Department of Honeywell. He was a visiting professor at ETH in Zurich in June and July, 1981. He gave there a graduate course on adaptive control.

In August Åström participated in the 8th IFAC World Congress in Kyoto, where he gave a plenary lecture on Adaptive Control. He was also elected to the IFAC Council. In September 1981 he gave lectures on stochastic control theory and adaptive control at the Arab Summer School in Bloudan, Syria. In December he participated in the 20th IEEE Conference on Decision and Control in San Diego, where he presented papers on computer aided engineering and adaptive control. In February 1982 he visited Rennes to be examiner of the PhD dissertation of Dr Fuchs. In May 1982 he visited University of Washington, S:t Lois, to give a lecture series on adaptive control.

Hilding Elmqvist made a visit to West Germany during four days in June 1981. He visited the following institutions in Karlsruhe: Frankhofer Institut für Informations und Datenverarbeitung (Steusloff), University (Informatik, Goos) and Kernforschungszentrum. He also visited University of München (Institut für Nachrichtentechnique, Färber) and University of Stuttgart (Institut fur Regelungstechnique, Lauber).

Elmqvist visited USA in November 1981. He first attended the ACM Annual Conference in Los Angeles. The following universities and industries were then visited: California Institute of Technology, University of Utah, IBM Research Lab in San José, Stanford University, Xerox PARC in De Anza, San José, Computer Corporation of America in Boston, MIT, Rensselaer Polytechnic Institute in Troy, and Carnegie Mellon University.

Per Hagander participated in the Fifth Annual Meeting of the Cell Kinetics Society, Asilomar, March 1-3, 1981 and presented a paper at the Workshop on Biomathematics and Cell Kinetics Asilomar, March 4-6. He also visited USC, Caltech, UCLA, Univ of Colorado and MIT.

TRAVELS

On March 22-24, 1982, Hagander participated in the Conference on Matrix Pencils in Piteå, Sweden.

<u>Sven Erik Mattsson</u> visited USA together with Sten Bergman (Sydkraft AB) from Nov 28 to Dec 11, 1981. They participated in and presented a paper at the AIAA 2nd Terrestrial Energy Systems Conference, Dec 1-3, 1981, Colorado Springs, Colorado. In California they visited Stanford University, Stanford, Systems Control Inc, Palo Alto, and Electric Power Research Institute (EPRI), Palo Alto.

<u>Gustaf Olsson</u> spent the academic year 1980-1981 as a visiting senior scientist at Systems Control Inc, Palo Alto, California. He gave several guest lectures and seminars in the USA during the year. He also cooperated with the Univ of Houston on a research project on wastewater treatment control, and visited the Weyerhaeuser Company, Tacoma, Washington, in September 1980 and April 1981 for discussions and seminars on wastewater treatment control. In August 1980 he presented a paper at the Joint Automatic Control Conference, San Francisco. He participated in the annual ISA conference in Houston, Texas, in October 1980. In December at the IEEE 19th CDC conference in Albuquerque, New Mexico, he chaired a session on Parameter estimation. In January 1981 he became the chairman of standing committee for international activities within the IEEE Control Systems Society. He participated in a workshop on Computer Aided Design, arranged by the General Electric Co and the Rensellaer Polytechnic Institute, in Schenectady, New York, in May 1981. In June he presented a paper and also delivered the final conference address at the IAWPR International Workshop on Practical Experience of Control and Automation in Wastewater Treatment and Water Resources Management, Munich, West Germany.

During the time July 15 - August 12, 1981, Gustaf Olsson returned to the USA to complete his work at Systems Control, Palo Alto, California. He then spent two weeks in Japan as a "research fellow", invited by the Department of Sanitary Engieering, Kyoto University. He participated in the 8th IFAC World Congress in Kyoto, presented one paper and chaired a session. In December 1981 he spent two weeks in the USA and participated in the IEEE Control and Decision Conference in San Diego, California, where he presented a paper. He also organized and chaired a session on Software for Computer Aided Design of Control Systems. He visited Canada Centre for Inland Waters, Burlington, Ontario as well as the Weyerhaeuser Company, Tacoma, Washington and the Rice University, Houston, Texas.

TRAVELS

<u>Björn Wittenmark</u> visited Univ of Connecticut in Dec 1980 where he gave seminars. At the 19th CDC in Albuquerque, New Mexico, he gave lectures at the workshop a Stochastic Adaptive Control. During the stay in USA he also visited Systems Control Inc in Palo Alto and Stanford University. On March 19-20, 1981, he visited NTH in Trondheim.

Wittenmark visited University of Salford, UMIST, Manchester, and Tec Quipment Ltd, Nottingham, during November 23-26, 1981, for discussions of laboratory equipment. June 1-12, 1982, he visited USA to discuss Computer Engineering education at Carnegie Mellon University, Rensselaer Polytechnique Institute and General Electric Corp. He also participated in the 6th IFAC Symposium on Identification and System Parameter Estimation in Washington.