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ACTIVITY REPORT
1977-78 1978-79

B. WITTENMARK
P. HAGANDER

LTH

Department of Automatic Control Lund Institute of Technology
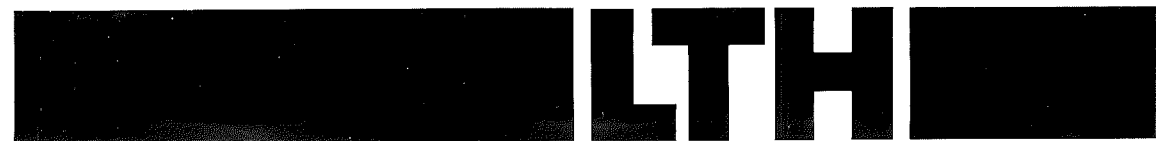
ACTIVITY REPORT
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1977-1978 and 1978-1979

Björn Wittenmark

Per Hagander

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Title and subtitle

Activity Report 1977-1978 and 1978-1979

A4   A5

Abstract

The report surveys the activities at the Department of
Automatic Control, Lund Institute of Technology, during
the academic years 77/78 and 78/79. During these two years
25 master theses and 7 PhD theses were completed.

The major areas of research have been system identification,
adaptive control and computer aided design of control sys-
tems. The applied research was devoted to adaptive ship
steering, control of waste water treatment plants, control
of heating and ventilation systems, and biomedical control
problems.

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TABLE OF CONTENTS

1. INTRODUCTION

In this report the activities over the academic years
77/78 and 78/79 are reported. The research projects are
briefly described and the main results and contributions
are summarized. Reports listed in the appendices give
further details. Only a limited number of copies of the
reports are available through the Department. It is,
however, possible to borrow the reports through the
University Library in Lund. Its address is:

University Library 2
Box 1010
S-221 03   LUND   Sweden

One main task has been to bring out the results of our
research to industry. We see a a growing interest for
the interactive programs SIMNON and IDPAC. These programs
are now available at about 10 computer centres. The pro-
grams are used by many engineers as a standard tool for
analysis and synthesis of control systems. There is also
a growing interest in applications of adaptive control.
The self-tuning regulators with their simplicity and
good performance will probably be used quite frequently
in the future.

We want to thank our sponsors, The Swedish Board of
Technical Development (STU), The Swedish Insitute of
Applied Mathematics (ITM), The National Board of Build-
ing Research (BFR), and the Swedish Water and Waste
Water Works Association (VAV) for their support to our
projects.

2. RESEARCH

The major research areas are:

>   Stochastic control theory
>   Computer aided design
>   Biological and medical systems
>   Applications

Stochastic control theory

Within this project we have been working with system identification and adaptive control. The research in system identification is now mainly done within application projects. The techniques and programs for identification have been used for modelling of for instance ships, waste water treatment plants, heating and ventilation systems, fluidized bed combusters, boiling water nuclear reactor, and extruder.

In order to bring out the knowledge about the identification program IDPAC, two courses were held during Spring 1979. About 35 persons from different industries participated and got on hands experience of the program. The material for the course have also been used by The Swedish Forest Products Research Laboratory (STFI).

The adaptice control project has continued with research on different types of self-tuning controllers. Self-
-tuning controllers based on pole-placement for servo applications have been developed. There are many different combinations of estimators and control design methods that can be used in order to get a self-tuning controller. To make it easier to investigate different combinations an interactive program based on SIMNON has been implemented.

The stability problem of adaptive control is of fundamental importance both in practice and theory. Some stability results on self-tuning regulators have been obtained. It can be shown that under reasonable assumptions the closed loop signals will be bounded if the disturbance is bounded.

Work has also been done leading to a unification of self-tuning regulators and model reference adaptive controllers. It is for instance shown that model reference adaptive controllers can be derived using the self-
-tuning approach. The augmented error in model reference adaptive controllers can be given a new interpretation and the nature of the often used positive real condition can be explained.

Another area of adaptive control that has been investigated is extremal control. There are many control problems that can be formulated as extremal control problems. Many different model structures and problem formulations have been suggested in the literature. A survey of different methods has been done and further research has been initiated.

Computer aided design

The interactive programs for computer aided design of control systems have recieved a lot of attention. The philosophy behind the interactive programs has been brought out through courses, papers and seminars. The programs are now available at many different places. The main work during the reported period has been devoted to structuring of the programs.

The programs are now easy to implement on different computers. The installation dependent routines are brought to a minimum and implementation guides are developed. All basic interaction is grouped into a package called INTRAC, which now is the basis for all our interactive software. INTRAC can also be used separately to make a set of FORTRAN routines interactive.

The following programs are now available at the department:

IDPAC	signal analysis and system identification
SIMNON	simulation of nonlinear differential and difference equations
SYNPAC	synthesis of linear quadratic controllers and simulation
MODPAC	analysis and transformation of linear systems

The programs are used in most of the other research activities at the department.

Biological and medical systems

The work on macromolecular transport has ended with a PhD thesis in Physiology at Uppsala University. It was demonstrated how dynamical experiments enables an investigation of mixed transport processes.

3. TRAVELS

Travels by the staff are listed in Appendix F.

During May 26-28, 1979, about 20 members of the depart-
ment made a tour to different industries in the western
part of Sweden. The following companies were visited:

    Volvo, Göteborg (Automobiles)
    LM Ericsson, Mölndal (Military electronics)
    BP Raffinaderi, Göteborg (Crude oil refining)
    Gruvöns Bruk, Grums (Paper and pulp)
    Kamyr AB, Karlstad (Continuous digesters for pulp)
    Uddeholms AB, Skoghall (Paper and pulp)
    Volvo Flygmotor, Trollhättan (Jet engines)
    Bofors AB, Bofors (Military equipment)
    Bäckhammars Bruk, Bäckhammar (Paper and pulp)

The purposes of the travel were to experience how auto-
matic control is applied in practice and to find out if
our education fills the need of the industries. All
participants felt that the travel gave much experience
and we want to thank the companies for their hospitality.

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APPENDIX A - LIST OF PERSONNEL

Professor

    Karl Johan Åström

University lecturers (Universitetslektorer)

    Gustaf Olsson
    Björn Wittenmark (in USA 77-78)
    Jan Holst (acting 77-78)

Research assistant (Forskarassistent)

    Per Hagander (PhD)

Research engineers (Forskningsingenjörer)

    Leif Andersson
    Bo Egardt (PhD 1978)
    Hilding Elmqvist (PhD 1978; in USA 78-79)
    Tommy Essebo (programmer)
    Ivar Gustavsson (PhD)
    Lars Jensen (PhD 1978)
    Claes Källström (PhD 1979)
    Ann-Britt Nilsson (programmer)
    Lars Pernebo (PhD 1978; in USA 78-79)
    Tomas Schönthal (programmer)
    Jan Sternby (PhD)
    Johan Wieslander (PhD 1979)

Teaching assistants (Assistenter)

    Per-Olof Gutman (PhD candidate; in USA 77-78)
    Tore Hägglund (PhD candidate)
    Matz Lenells (PhD candidate)
    Carl Fredrik Mannerfelt (PhD candidate)
    Sven Erik Mattsson (PhD candidate)
    Per Molander (PhD candidate)

Laboratory engineer (Laboratorieingenjör)

    Rolf Braun

Visiting scientists (Gästforskare)

    Prof Rod Bell (Sep 78 - May 79)
        MacQuarie University, Australia

    Prof Alan Foss (May - June 78)
        University of California, Berkeley, USA

    Dr Toni Havlichek (April - June 78)
        Czechoslovak Academy of Science, Prague,
        Czechoslovakia

    Dr David Hill (Sep - Dec 78)
        University of Melbourne, Australia

    Dr Mogens Levin (Sep - Dec 77)
        DTH, Lyngby, Denmark

    Prof Lou Westphal (Sep - Dec 78)
        University of Queensland, Australia

Technical drawings (Tekniskt biträde)

    Britt-Marie Carlsson

Secretaries (Sekreterare)

    Eva Schildt
    Eva Dagnegård (half time)
    Lilian Andersson (part time)

Typist (Skrivhjälp)

    Kerstin Ulveland

APPENDIX B - PUBLISHED PAPERS AND CONFERENCE
CONTRIBUTIONS

Åström K J: Piece-wise deterministic signals. Symposium
on Systems Optimization and Analysis, IRIA, Paris,
France, Dec 1978.

Åström K J: Stochastic control problems. Mathematical
Control Theory, Proc, Canberra, Australia 1977.
Editor W A Coppel, Springer-Verlag, Heidelberg
1978.

Åström K J: Algebraic system theory as a tool for regu-
lator design. Acta Polytechnica Scandinavia, Ma 31,
Topics in System Theory. Publication in honour of
Prof Hans Blomberg on the occation of his sixtieth
birthday on December 18th, 1979.

Bergman S, Gustavsson I: Identification of global noise
in a boiling water reactor by means of spectral
and parametric methods. J Nuclear Science and
Technology 16 (1979) 77-88.

Egardt B, Molander P: Multivariable root-loci for
positive real transfer matrices. Int J Control 28
(1978) 253-259.

Egardt B: Unification of some continuous-time adaptive
control schemes. IEEE Trans Automatic Control
AC-24 (1979) 588-592.

Egardt B: Stability of Adaptive Controllers. Springer-
-Verlag, Berlin Heidelberg, 1979.

Gillblad T, Olsson G: Computer control of a medium sized
activated sludge plant. Prog Wat Tech 9 Nos 5/6
(1977) 427-433.

Gutman P O, DiStefano J J: Parameters of thyronine meta-
bolism from normal and pathological human data:
Some numerical results concerning parameter esti-
mates, their variability and their possible utility
in diagnostic classification. Report UCLS-ENG-7730,
Univ of California, Los Angeles, April 1977.

Hagander P: Modeling and insulin-glucose control. VIIe
Colloque International du College de France sur le
Théme: L'Idée de Régulation dans le Mouvement des
Sciences, Dec 5-10, 1977.

Hagander P, Tranberg K-G, Thorell J, DiStefano J J:
Models for the insulin response to intravenous
glucose. Mathematical Biosciences 42 (1978) 15-30.

Hamza M H, Tödtli J, Wittenmark B: Prediction of
    natural gas disposition. Symposium on Simulation,
    Modelling and Decision in Energy Systems, Montreal,
    June 1-2, 1978.

Källström G, Åström K J, Thorell N E, Eriksson J,
    Sten L: Adaptive autopilots for large tankers.
    IFAC World Congress, Helsinki, June 12-16, 1978,
    pp 477-484. Also in Automatica 15 (1979) 241-254.

Källström C G, Byström L: System identification of
    linear and nonlinear ship steering dynamics. 5th
    Ship Control Systems Symposium, Annapolis, Mary-
    land, USA, 1978.

Lee K G, Wittenmark B, Kleinmann D L: Identification of
    parameters in the optimal control model. 14th
    Annual Conference on Manual Control, Los Angeles,
    April 25-27, 1978.

Norrbin N H, Byström L, Åström K J, Källström C G:
    Further studies of parameter identification of
    linear and nonlinear ship steering dynamics.
    Report 1920-6, Swedish State Shipbuilding Experi-
    mental Tank, Gothenburg, Sweden, Sep 1977.

Olsson G: Automatic control in combined wastewater
    treatment plants. Invited paper, Int Environmental
    Colloquium, Liége, Belgium, May 1978.

Olsson G, Andrews J: Estimation and control of bio-
    logical activity in the activated sludge process
    using dissolved oxygen measurements. IFAC Symp on
    Environmental Systems Planning, Design and Control,
    Kyoto, Japan, Aug 1977.

Olsson G, Andrews J: The dissolved oxygen profile - a
    valuable tool for control of the activated sludge
    process. Water Research 12 (1978) 985-1004.

Olsson G: Swedish experiences in instrumentation and
    control of wastewater treatment plants. Institut
    Recherche Chimie Applique, Paris, Dec 1978.

Olsson G: Process control in wastewater treatment
    plants - a survey (in Swedish). Swedish Associa-
    tion for water and wastewater works, M26, pp 13-72,
    April 1979.

Olsson G: Automatic control in wastewater treatment
    plants. Invited paper, Int Environmental Colloqui-
    um, Liége, Belgium, May 1979.

Pernebo L, Sternby J: Simulation of two suboptimal dual
    controllers. Int J Control 28 (1978) 545-556.

Pernebo L: An algebraic theory for design of controllers for linear multivariable systems, Part 1 - Structure matrices and feedforward design. Univ of Southern California, Los Angeles, California, May 1979.

Pernebo L: An algebraic theory for design of controllers for linear multivariable systems, Part 2 - Feedback realizations and feedback design. Univ of Southern California, Los Angeles, California, May 1979.

Rao P K, Wittenmark B: Suboptimal minimum energy controllers for process control. Symposium on Simulation, Modelling and Decision in Energy Systems, Montreal, June 1-2, 1978.

Rutili G, Hagander P: Transport of macromolecules in subcutaneous tissue. In G Rutili: Transport of Macromolecules in Subcutaneous Tissue Studied by FITC-Dextran. Acta Universitas Uppsaliensis, Abstracts of Uppsala Dissertations from the Faculty of Medicine 306, Uppsala, 1978.

Silverman L M, Pernebo L: Balansed systems and model reduction. Optimization Days, McGill University, Montreal, Canada, May 1979.

Sternby J: A regulator for time-varying stochastic systems. Paper 46B.4, IFAC World Congress, Helsinki, June 12-16, 1978.

Sternby J: Comments on 'Convergence of least squares identification algorithms applied to unstable stochastic processes'. Int J Systems Sci 9 (1978) 837-838.

Söderström T, Ljung L, Gustavsson I: A theoretical analysis of recursive identification methods. Automatica 14 (1978) 231-244.

Wittenmark B: Self-tuning algorithms for control, prediction and smoothing. Invited paper, Institute of Mathematical Statistics Meeting on Time Series Analysis, Ames, May 1-3, 1978.

Wittenmark B: A two-level estimator for time-varying parameters. Automatica 15 (1979) 85-89.

Wittenmark B, Rao P K: Comments on 'Single step versus multistep performance criteria for steady state SISO systems'. IEEE Trans Automatic Control AC-24 (1979) 140-141.

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APPENDIX C - REPORTS

- Any of the listed publications may be borrowed through
  your library service or from the University Library in
  Lund:

        UB2
        Box 1010
        S-221 03 Lund, Sweden

- The reports in 1000- and 3000-series may be ordered
  from

        Department of Automatic Control
        Lund Institute of Technology
        Box 725
        S-220 07 Lund 7, Sweden

- There is a copying and handling charge of between $6.00
  and $25.00 for each document. Invoice will be sent
  together with the ordered report(s).

- Please be certain to include both the report number
  and the title.

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DISSERTATIONS

TFRT-1013   Holst J: Adaptive prediction and recursive estimation. Sep 1977.

TFRT-1014   Jensen L: Digital reglering av klimatprocesser (Digital control of climate processes). May 1978.

TFRT-1015   Elmqvist H: A structured model language for large continuous systems. May 1978.

TFRT-1016   Pernebo L: Algebraic control theory for linear multivariable systems. May 1978.

TFRT-1017   Egardt B: Stability of model reference adaptive and self-tuning regulators. Dec 1978.

TFRT-1018   Källström C G: Identification and adaptive control applied to ship steering. May 1979.

TFRT-1019   Wieslander J: Interaction in computer aided analysis and design of control systems. May 1979.

FINAL REPORTS

TFRT-3147   Åström K J: Stochastic control problems. Nov 1977.

TFRT-3148   Åström K J, Westerberg B, Wittenmark B: Self-tuning controllers based on pole-placement design. May 1978.

TFRT-3149   Wieslander J, Elmqvist H: INTRAC. A Communication module for interactive programs. Language manual. Aug 1978.

TFRT-3150   Åström K J, Gustavsson I: Analysis of a self-tuning regulator in a servoloop. Oct 1978.

TFRT-3151   Åström K J: Self-tuning control of a fixed bed chemical reactor system. Nov 1978.

TFRT-3152   Åström K J, Gustavsson I: Reglering under osäkerhet (Stochastic control). Dec 1978.

TFRT-3153   Åström K J: Robustness of a design method based on assignment of poles and zeros. May 1979.

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TFRT-4009   Åström K J, Olsson G: Activity report 1976-
             -1977. May 1978.

MASTER THESES

TFRT-5197   Gestrelius S: Hodkin-Huxley modellen anpas-
             sad till lågfrekventa nervimpulser (The
             Hodgkin-Huxley model applied to low frequen-
             cy repetetive firing nerves). Aug 1977.

TFRT-5198   Westerberg B: Självinställande regulator
             baserad på polplacering (A self-tuning
             regulator based on pole-placement). Aug
             1977.

TFRT-5199   Nordström H, Svensson L: Mätning, modell-
             bygge, simulering och reglering tillämpat
             på en anläggning med värmepump (Measuring,
             modelling, simulation, and control of a
             heat-pump). Sep 1977.

TFRT-5200   Holmqvist B, Larsson L-E: Laboratoriepro-
             cess för flödessystem (Laboratory process
             for flow systems). Aug 1977.

TFRT-5201   Persson C: Generell assembler i STAGE 2
             (General assembler in STAGE 2). Oct 1977.

TFRT-5202   Pålsson T, Rading L: Program för loggning
             och dataanalys på PDP11/03 (Program for
             logging and data analysis on PDP11/03).
             Nov 1977.

TFRT-5203   Karlström H: Minidatorsystem för styrning
             av hängtransportöranläggning (A computer
             system for mailbag sorting). Dec 1977.

TFRT-5204   Vonheim T: Mikrodatorreglering av en tunnel-
             ugn (Microcomputer control of a tunneloven).
             Dec 1977.

TFRT-5205   Apelblat J, Rydström P: Frånluftstemperatur-
             reglering av flerfamiljshus (Return air
             temperature control of an apartment house).
             Dec 1977.

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TFRT-5206 Andersson J, Melin J: Bestämning av para-
metrar i dynamisk modell för insulinsvar
på glykoslast (Quantification of parameters
of a dynamic model for insulin response to
glucose load). January 1978.

TFRT-5207 Larsson C, Lindgren H: Program för frekvens-
analys på PDP11/03 (Program for frequency
analysis on PDP11/03). May 1978.

TFRT-5208 Lindgren S: Decentraliserad reglering av
stora system med självinställande regulato-
rer (Decentralized control of large-scale
systems using self-tuning regulators). May
1978.

TFRT-5209 Hägglund T: Reglering av yoghurttillverk-
ning (Control of youghurt manufacturing).
May 1978.

TFRT-5210 Hallström L-G: Generella beräkning på mät-
data (Interactive program for computations
on data files). June 1978.

TFRT-5211 Nilsson B, Tillberg K: Analys av reglersys-
temet till en cigarettmaskin (Analysis of
the control system for a cigarette machine).
June 1978.

TFRT-5212 Josefson G: Dynamiska modeller för belast-
ning på ett kraftsystem (Dynamic models for
the load on a power system). June 1978.

TFRT-5213 Blom A, Tengvall F: Digital reglering av
brännportal (Digital control of a cutting
machine). July 1978.

TFRT-5214 Norén P: Mikrodatorbaserat positionerings-
system för ASEA IRb-system (Microcomputer
based positioning system for ASEA IRb-sys-
tem). Oct 1978.

TFRT-5215 Olesen J, Jensen C: Identifiering av
strängspruta (Identification of extruder
dynamics). Oct 1978.

TFRT-5216 Wiberg S: Analys av extruder (Analysis of
an extruder). Oct 1978.

TFRT-5217 Hultqvist G: Datastyrd svetsautomat –
hårdvara (Computer controller welding
machine – hardware). Nov 1978.

TFRT-5218 Upadhyaya L: Glykos insulin reglering
(Glycose and insulin regulation). Dec 1978.

TFRT-5219   Löfgren L: Minidatorreglerad smältmaterial-
            hantering (Minicomputer control of the
            mixing of materials of a melting plant).
            Dec 1978.

TFRT-5220   Johansson G, Jonasson K: Simulering av
            ämnestemperaturer i en stegbalksugn (Simu-
            lation of slab temperatures in a walking
            beam furnace). March 1979.

TFRT-5221   Ahlström A: Mätningar och experiment på
            laboratorieprocesser (Measurements and
            experiments on laboratory processes). May
            1979.

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TFRT-6008   Holst J: Master theses in Automatic Control
            76/77. Feb 1978.

TFRT-6009   Wittenmark B: Master theses in Automatic
            Control 77/78. March 1979.

INTERNAL REPORTS

TFRT-7121   Razevig V D: Digital simulation of contin-
            uous stochastic systems. May 1977.

TFRT-7122   Molander P: Stability of feedback systems
            with relays or saturations. Aug 1977.

TFRT-7123   Mannerfelt C F: Ett exempel på numeriska
            svårigheter vid beräkning av nollställen
            (An example of numerical problems associ-
            ated with the computation of system zeros).
            Oct 1977.

TFRT-7124   Hagander P: Simulation programs for the
            Grodsky insulin-glucose model. Nov 1977.

TFRT-7125   Jensen L: Energibesparing vid entalpistyr-
            ning (Energy reduction with enthalpy con-
            trol). Nov 1977.

TFRT-7126   Jensen L: Självinställande startoptimering
            (Self-adjusting start optimization). Nov
            1977.

TFRT-7127   Apelblat J, Jensen L, Rydström P: Från-
            luftstemperaturreglering av flerfamiljshus
            (Control of return air temperature in
            apartment buildings). Nov 1977.

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TFRT-7128   Schönthal T: INTRAC - Programmer's guide.
             Oct 1977.

TFRT-7129   Källström C G: Identification of the linear
             steering dynamics of the Sea Splendour.
             Dec 1977.

TFRT-7130   Källström C G: Determination of linear and
             nonlinear steering models for the USS
             Compass Island. Dec 1977.

TFRT-7131   Källström C G: Identification of the steer-
             ing dynamics of the Sea Scout. Dec 1977.

TFRT-7132   Elmqvist H: A new model language for con-
             tinuous systems. Dec 1977.

TFRT-7133   Bengtsson G, Egardt B: Internal properties
             and insensitive implementations of the Otto
             Smith regulator. Jan 1978.

TFRT-7134   Egardt B: A unified approach to model re-
             ference adaptive systems and self-tuning
             regulators. Jan 1978.

TFRT-7135   Åström K J, Olsson G, Wittenmark B, Holst J:
             Kursplanerevisioner i reglerteknik (Revi-
             sions of undergraduate courses in Automatic
             Control). Feb 1978

TFRT-7136   Olsson G: Instrumentation and control of
             wastewater treatment plants in the USA.
             March 1978.

TFRT-7137   Gillblad T, Olsson G: Implementation prob-
             lems for activated sludge controllers.
             March 1978.

TFRT-7138   Ahlström A, Bergström J, Hallström L G,
             Hägglund T, Johansson B, Knorring O von,
             Larsson B, Lindsten L G, Pettersson H Å,
             Skoglund T, Tyren C, Vollmer L: Reglering
             av nivå och temperatur (Level and tempera-
             ture control). March 1978.

TFRT-7139   Schönthal T: MODPAC V3A - Command guide.
             March 1978.

TFRT-7140   Egardt B: Unification of some adaptive con-
             trol schemes - Part I: Continuous time.
             June 1978.

TFRT-7141   Olsson G: Automatic control in combined
             wastewater treatment plants. Invited paper,
             Int Environmental Coll, Liége, May 16-19,
             1978. May 1978.

TFRT-7142   Sternby J: Analysis of an extremal con-
             troller for Hammerstein models. June 1978.

TFRT-7143   Sternby J: Turn-off reduction for the
             cautious regulator - a simulation study.
             June 1978.

TFRT-7144   Sternby J: Certainty equivalence and an
             identification problem from econometry.
             June 1978.

TFRT-7145   Sternby J: Performance limits in adaptive
             control. June 1978.

TFRT-7146   Holst J: Adaptive short-term prediction of
             power load. Load data. Aug 1978.

TFRT-7147   Källström C G: Lispid - User's manual.
             Aug 1978.

TFRT-7148   Elmqvist H: Simnon - An interactive simu-
             lation program - Implementation. Aug 1978.

TFRT-7149   Gustavsson I: User's guide for a program
             package for simulation of self-tuning
             regulators. Aug 1978.

TFRT-7150   Mattsson S E: Evaluation of a subroutine
             for Nelder and Mead search. Sep 1978.

TFRT-7151   Gillblad T, Olsson G: Styrning av avlopps-
             reningsverk (Control of wastewater treat-
             ment works). May 1978.

TFRT-7152   Egardt B: Unification of some adaptive
             control schemes. Part I - Continuous time.
             Part II - Discrete time. Oct 1978.

TFRT-7153   Havlíĉek A, Gustavsson I: Dynamical identi-
             fication of the cooling system in a fluid-
             ized bed combustor. Oct 1978.

TFRT-7154   Andersson L, Åström K J: An interactive
             MISO regulator. Oct 1978.

TFRT-7155   Källström C G: Identification of the steer-
             ing dynamics of the Sea Swift. Oct 1978.

TFRT-7156   Mattsson S E: A simple real-time scheduler.
             Nov 1978.

TFRT-7157   Källström C G: Identification of the steer-
             ing dynamics of Sea Stratus. Nov 1978.

TFRT-7158   Olsson G: Swedish experiences of instru-
mentation and control of wastewater treat-
ment plants. Dec 1978.

TFRT-7159   Olsson G: Experiences Suedoises relatives
a l'instrumentation et a la regulation en
stations d'epuration. Dec 1978.

TFRT-7160   Olsson G: Processreglering i reningsverk
– en översikt (Process control in waste-
water treatment plants – a survey). Dec
1978.

TFRT-7161   Sternby J: A review of extremum control.
April 1979.

TFRT-7162   Bell R D, Åström K J: A low order nonlinear
dynamic model for drum boiler-turbine-
-alternator units. April 1979.

TFRT-7163   Åström K J, Bell R D: A simple drum level
model. May 1979.

TFRT-7164   Åström K J: Algebraic system theory as a
tool for regulator design. May 1979.

TFRT-7165   Bergman S-Å, Bjerke O, Dymling S, Grgiĉ A,
Grimsberg M, Henningsson B, Kleverman M,
Månsson L, Nielsen L, Svensson G: Regler-
ing av farkoster (Control of vehicles).
March 1979.

TRAVEL REPORTS

TFRT-8022   Åström K J: Visit to the Department of
Automatic Control, ETH, Zürich, February
1977. May 1977.

TFRT-8023   Wittenmark B: Travel report from USA –
July 1, 1977 – July 3, 1978. Oct 1978.

APPENDIX D - COURSES AND SEMINARS AT THE DEPARTMENT

Undergraduate courses, graduate courses, seminars as
well as external courses, given at the department during
the years 1977/78 and 1978/79, are summarized here.
They are given both by the staff at the department, and
by invited lecturers.

Undergraduate courses

Linear systems (Reglerteknik AK)
Principles of automatic control
Control theory for chemical engineers
Nonlinear and sampled data systems
Systems engineering
Computers in control systems I and II

Ph D Courses

The following courses have been given:

Optimization methods   (P Hagander)
Stability theory   (P Hagander)
Stochastic control theory   (P Hagander)
Methods for the analysis and characterization of
      physiological phenomena. Graduate course for
      medical students, Lund (20 lectures) (P Hagander)
Control system design   (I Horowitz (Israel), M Mansour
      (ETH Zürich), K J Åström, A Foss (Berkeley, Calif))
Identification   (K J Åström)
Adaptive control   (K J Åström)
Linear system theory   (K J Åström)

Seminars

1977

Sep 1   Jan Holst: Local convergence of some recur-
           sive estimation algorithms.

Sep 5   Jan Holst: ARMA process prediction.

Sep 9   Jan Holst: Adaptive prediction.

Sep 20   Prof M Mansour (ETH Zürich): Schwarz matrix
           form in the analysis of continuous and
           discrete systems.

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1977

Sep 22   M Mansour: Quadratic performance indices and
          the margin of stability for linear continuous
          and discrete systems.

Sep 29   Per Hedelin (Chalmers Inst of Technology,
          Göteborg): Reduced order smoothing.

Sep 30   Leif Andersson: An introduction of the LSI 11
          computer.

Oct 6   Jan Sternby: Grinding of rocks.

Oct 7   Prof Göran Einarsson (Dept of Telecommunica-
          tion Theory, Lund): Differential PCM.

Oct 14   Torkel Glad: Impressions from a year in the
          USA.

Oct 18-27 Prof Isaac Horowitz (Weizmann Inst of Science,
          Israel): Quantitative synthesis techniques
          and plant uncertainty. Six seminars.

Oct 28   Ivar Gustavsson and Jan Sternby: Self-tuning
          prediction.

Nov 10   Bo Egardt: Model reference adaptive systems.

Nov 11   K J Åström: Linear quadratic control synthe-
          sis, Introduction.

Nov 18   Dr Göran Salomonsson (Dept of Telecommunica-
          tion Theory, Lund): Adaptive equalizers.

Nov 23   N Leth (DTH, Lyngby, Denmark): Design of a
          servo system.

Dec 19   Prof Ruth Curtain (Gronningen, the Nether-
          lands): Controllability and observability con-
          cepts for infinite dimensional systems.

1978

Jan 25   Jan Sternby: Begränsningar vid adaptiv styr-
          ning (Performance limits in adaptive control).

Feb 8   K J Åström et al: Ett processtyrningsspråk
          (A new process control language).

Feb 17   Per Hagander: Stability theory, Introduction.

Feb 23   Hilding Elmqvist: Introduction into the
          Dymola language.

1978

March 1, Per Hagander: Stability theory.
3, 10

March 17 Curt Wells (Dept of Economics, Lund univ):
          Optimal economical policy.

March 21 Johan Wieslander: New interactive programs:
          MODPAC.

Apr 14   Dr Toni Havlichek (Prague): Statistical mod-
          eling and analysis of chemical processes.

Apr 21   Lars Pernebo: Algebraic design theory I.

Apr 24   Prof John Rijnsdorp (the Netherlands): Man's
          role in control systems.

Apr 28   Lars Pernebo: Algebraic design theory II.

May 8   Lars Pernebo: Albegraic design theory III.

May 9   Prof Alan Foss (Univ of California, Berkeley):
          Survey of research on chemical reactor control.

May 10   Alan Foss: Dynamic models of fixed-bed reac-
          tors.

May 12   Alan Foss: Parameter determination for reac-
          tor model.

May 16   Alan Foss: Development of control system con-
          figuration.

May 17   Alan Foss: Reconstruction design and experi-
          mental results.

May 19,26 Hilding Elmqvist: A structured model language
          for large continuous systems, I and II.

May 26   Hilding Elmqvist: Compiler technique, formula
          treatment and the Dymola compiler.

May 31   Svante Jahnberg (Research Institute of Na-
          tional Defense (FOA), Stockholm): Microcom-
          puters - some development features.

June 2   Prof Howard Rosenbrock (UMIST, Manchester,
          England): Representation of state.

June 6   Prof Peter Falb (Brown univ, Providence RI,
          USA): Linear systems with variable parame-
          ters I.

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1978

June 7   Peter Falb: Linear systems with variable
          parameters II.

June 7   Prof M Athans (MIT, Cambridge, Mass, USA):
          Toward reliable control system synthesis.

June 7   Dr Austin Spang III (General Electric,
          Schenectady, USA): Insight into the applica-
          tion of the inverse Nyqvist array method to
          turbofan engines.

June 8   Prof I D Landau (Grenoble, France): Bilinear
          modelization of distillation columns.

June 8   M Athans: Systems aspects of complex manufac-
          turing networks.

June 8   Prof Tim Johnson(MIT, Cambridge, Mass, USA):
          On-line identification of bio-electrode para-
          meters.

Aug 28   Dr Mike Grimble (Sheffield, England): Finite
          time optimal control in the s-domain.

Aug 30   M Grimble: S-domain solution of the filter-
          ing problem.

Sep 4   Prof Don Wiberg (UCLA, Los Angeles, USA):
          Applications of parameter identification to
          respiratory physiology.

Sep 7   Dr Lou Westphal (Univ of Queensland, Austral-
          ia): Parameter identification by systematic
          variation of partitioned adaptive filters.

Sep 9   K J Åström: Linear quadratic or frequency
          domain methods?

Sep 13   Björn Wittenmark: A two-level estimator.

Sep 14   Dr G Favier (L'université de Nice, France):
          New stochastic realization algorithms for
          identification of ARMA models.

Sep 15   Prof R W H Sargent (Imperial College, London,
          England): Selection of measurements for op-
          timal feedback control.

Sep 19   Dr Rod Bell (MacQuarie Univ, Australia):
          Model and control studies for large power
          generating plants.

Oct 20   Björn Wittenmark: Impressions from a year in
          USA.

1978

Oct 26   K J Åström: Self-tuning regulators based on
         pole-placement design I.

Nov 17   K J Åström: Self-tuning regulators based on
         pole-placement design II.

Nov 30   Dr David Hill (Univ of Melbourne, Australia):
         Hierarcal systems.

1979

Feb 13   Prof Raman Mehra (SSI, Cambridge, USA): Non-
         linear systems and bifarcation.

March 9 Dr Lazlo Kevizcky (Budapest, Hungary): Non-
         linear identification in the practice of
         DATUB closed loop grinding mill models.

March 13 Prof Steve Morse (Yale Univ, New Haven, USA):
         Decentralized control.

March 14 S Morse: Transportation system scheduling.

March 15 S Morse: Adaptive control.

March 19 Prof R Mohler (Oregon State Univ, Portland,
         USA): Overview of bilinear systems.

March 20 Per-Olof Gutman: Controllers for bilinear
         systems.

March 21 R Mohler: Process control applications of
         bilinear systems.

March 30 Civ ing Dan Andrée (KTH, Stockholm): Dynami-
         cal systems with abrupt changes of coeffi-
         cients.

May 15   Övering Jonas Agerberg (FOA, Stockholm): ADA.

May 15   Prof André Titli (LAAS, Toulouse, France):
         Hierarcal systems.

May 16   Dr Vladimir Kucera (Czeckoslovak Academy of
         Science, Prague, Czechoslovakia): Polynomial
         equations approach to design of controllers.

May 17   Prof Neil Munro (Manchester Univ, Manchester,
         England): Application of inverse Nyquist.

June 7   Prof N A Lindberger (KTH, Stockholm): Random
         walk between reflecting walls - A family of
         test signals for nonlinear systems.

1979

June 11   Dr George Axelby (Westinghouse, Baltimore,
          USA): Reflections on computations in control
          - An industrial viewpoint.

June 12   Per Molander: A system analysis symposium.

June 21   Dr Gerry Bierman (JPL, Pasadena, USA):
          Numerical aspects of control and estimation.

External courses

I. Climate control in buildings.
The course was held 22-24 May 1978 and given for indus-
trial and university people. It included the following
lectures:

1. K J Åström: Control of climate processes, an intro-
    duction.

2. G Olsson: Disturbances, models, control, a survey.

3. L Jensen: Dynamical properties of climate processes.
    Room dynamics, air flow channels, heat exchangers.

4. K J Åström: Simple controllers. Feed forward, feed-
    back.

5. L Jensen: Self-tuning regulators. Application on a
    heat pump.

6. G Olsson: Simulation as a design tool.

7. G Olsson: The computer as a component in climate
    systems.

8. L Jensen: Computer control. Start-up, supervision,
    control. A special control language.

9. K Andersson (Skånska Cementgjuteriet, Stockholm):
    Practical applications.

II. Introductory control theory.
This was given as a one-day seminar for food technology
students, April 1978.

III. Process identification.
Two identical four-day courses were held April 2-5,
1979, and May 8-11, 1979, and given for industrial

people. The following lectures were given:

1. K J Åström: Process identification - Introduction.

2. B Wittenmark: Frequency and transient analysis.

3. I Gustavsson: Correlation analysis.

4. J Wieslander: Interactive programs.

5. J Sternby: The least squares method.

6. B Egardt: The maximum likelihood method.

7. G Olsson, I Gustavsson: Experiment planning.

8. K J Åström: Process identification - a survey.

9. C G Källström, B Egardt: Applications.

10. B Egardt: Adaptive control.

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APPENDIX E - LECTURES BY THE STAFF

1977

Aug 5   K J Åström: System identification. Univ of Queensland, Australia.

Aug 17   K J Åström: Adaptive control. Univ or New South Wales, Australia.

Aug 23-
-Sep 2   K J Åström: Stochastic control theory (six lectures). Australian National University, Camberra. Published in W A Coppel (ed): Mathematical Control Theory, Springer Verlag, 1978.

Sep 7   K J Åström: Modeling and optimization - an overview. Symposium on mathematical modeling in food processing, Örenäs, Sweden.

Fall   Björn Wittenmark: Identification of dynamic systems (14 lectures, 42 hours). Univ of Connecticut, USA.

Sep 14   Claes Källström: Description of the adaptive autopilot for tankers. Simulations and experiment. Lectures at the Kockum Shipyard, Malmö, Sweden.

Sep 20   Björn Wittenmark: Design of digital controllers. Univ of Connecticut, USA.

Sep 26   Claes Källström: Maximum likelihood estimation of coefficients in the dynamic equations. Course on "Maneuvring of Marine Structures", NTH, Trondheim, Norway.

Sep 30   Bo Egardt: Modell-referens regulatorer (Model reference adaptive regulators). Dept of Electrical Engineering, Linköping University, Sweden.

Oct 4-5   Claes Källström: Identification of ship dynamics. Interactive program for the simulation of dynamic systems - Simnon. Simulation of control systems for super tankers.
3 lectures in a course on interactive program systems, NTH, Trondheim, Norway.

Oct 12   Björn Wittenmark: Self-tuning algorithms for control, prediction and smoothing. Honeywell, Minneapolis, USA.

1977

Oct 18   Björn Wittenmark: Self-tuning algorithms for control, prediction and smoothing. Univ of Massachusetts, Amherst, USA.

Oct 28   Per Molander: Convergence of recursive stochastic algorithms with applications to system identification. Gronningen University, the Netherlands.

Nov 14-17 Johan Wieslander: Modern control theory. 3 lectures at a course on computers in the process industry, Huskvarna, Sweden.

Nov 23   G Olsson: Interactive programming. Danish Institute of Technology, Lyngby, Denmark.

Dec 9   Jan Holst: Adaptive prediction, theory and applications. Linköping University, Sweden.

1978

Jan 10-11 Jan Sternby: Dual control. Self-tuning regulators. Dept of Statistics, Umeå Univ, Sweden.

Jan 17   Björn Wittenmark: Self-tuning algorithms for control, prediction and smoothing. Case Western Reserve University, Cleveland, USA.

Jan 19   Björn Wittenmark: Self-tuning algorithms for control, prediction and smoothing. Univ of Minnesota, Minneapolis, USA.

Feb 14   Björn Wittenmark: Introduction to self-tuning regulators. Univ of Connecticut, USA.

Feb 21   Björn Wittenmark: Self-tuning regulators - the algorithm. Univ of Connecticut, USA.

Feb 23   Björn Wittenmark: Self-tuning algorithms for control, prediction and smoothing. Rensselaer Polytechnic Institute, Troy, USA.

Feb 28   Björn Wittenmark: Self-tuning regulators - the properties of the algorithm. Univ of Connecticut, USA.

March 7   Björn Wittenmark: Self-tuning regulators - pole placement algorithms. Univ of Connecticut, USA.

March 13 G Olsson: Dissolved oxygen control. Water Research Centre, Stevenage, England.

1978

April 4   Björn Wittenmark: Self-tuning algorithms for
           prediction and smoothing. Univ of Connecticut,
           USA.

April 7   K J Åström: Application of self-tuning regu-
           lators. Science Research Council, Vacation
           School on Stochastic Processes in Control
           Systems, Univ of Warwick, England.

April 10   Johan Wieslander: Modern control theory.
   -13   Repeat of the course fron Nov 14-17, 1977.

April 11   Björn Wittenmark: Industrial applications of
           self-tuning regulators. Univ of Connecticut,
           USA.

April 18   K J Åström: Self-tuning regulators with
           deterministic inputs. Univ of Grenoble,
           France.

May 2   Björn Wittenmark: Self-tuning algorithms for
           control, prediction and smooting. Invited
           presentation at the Institute of Mathematical
           Statistics Meeting on Time Series Analysis,
           Iowa State University, Ames, USA.

May 8   Björn Wittenmark: Adaptive control - indus-
           trial tool or academic toy. Univ of Connecti-
           cut, USA.

May 10   Ivar Gustavsson: Process identification -
           Experiences from different applications.
           Dept of Electrical Engineering, Linköping
           University, Sweden.

May 17   Gustaf Olsson: Automatic control in combined
           wastewater treatment plants. Int Environ-
           mental Colloquium, Liége, Belgium.

May 24   Per Molander: On the design of high-gain
           feedback regulators and observers. Twente
           Tekniska Högskola, Enschede, the Netherlands.

May 31   Björn Wittenmark: Self-tuning algorithms for
           control, prediction and smoothing. McGill
           University, Montreal, Canada.

May 31   Jan Holst: Adaptive prediction of electric
           power consumption. Luleå Institute of Tech-
           nology, Luleå, Sweden.

June 2   Björn Wittenmark: Suboptimal minimum energy
           controllers for process control. Symposium
           on Simulation, Modelling and Decision in
           Energy Systems, Montreal, Canada.

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1978

June 12   Jan Holst: Some practical applications of
           stochastic control theory. Summer school,
           Swedish Statistical Soc, Saltsjö-boo, Sweden.

June 12   IFAC World Congress, Helsinki, Sweden.
- 16   Claes Källström and K J Åström: Adaptive
           autopilots for large tankers.
           Jan Sternby: A regulator for time-varying
           stochastic systems.
           K J Åström: Invitation presentation for Round
           table on the next decade of control theory
           and applications. (See Automatica 15 (1979)
           361-363).

June 17   Jan Sternby: Dual control. Summer school,
           Swedish Statistical Soc, Saltsjö-boo, Sweden.

June 29   Björn Wittenmark: Self-tuning algorithms for
           control, prediction and smoothing. Yale
           University, New Haven, USA.

Aug 15   G Olsson: The use of the dissolved oxygen
           profile as a tool for activated sludge con-
           trol. Research lab, Metropolitan Sanitary
           District of Greater Chicago, Chicago, USA.

Aug 30   K J Åström: Självinställande regulatorer
           (Self-adjusting regulators). Servolaborato-
           riet, DTH, Lyngby, Denmark.

Sep 18   K J Åström: Adaptive autopilots for ship
           steering. Electronic Systems Laboratory, MIT,
           Cambridge, USA.

Sep 19   K J Åström: Self-tuning regulators with de-
           terministic inputs. Harvard University,
           Cambridge, USA.

Sep 20   K J Åström: Adaptive controllers based on
           pole zero assignments. Brown University,
           Providence, RI, USA.

Sep 21   K J Åström: Adaptive control. Yale Universi-
           ty, New Haven, Connecticut, USA.

Sep 26   K J Åström: Adaptive control - a survey.
           General Electric Research Lab, Schenectady,
           USA.

Sep 26   K J Åström: Progress in control theory. Int
           Symp on Process Control for the Pulp and
           Paper Industry, Monterey, California, USA.

1978

Oct 12   Lars Pernebo: Algebraic design theory.
            Univ of Southern California, Los Angeles,
            USA.

Nov 9   K J Åström: Framsteg inom reglertekniken
            (Progress in control theory). SPCI Svenska
            Pappers- och Cellulosa Ingenjörsföreningen,
            Stockholm, Sweden.

Nov 15   K J Åström: Adaptiv reglering (adaptive
            control). University of Aalborg, Denmark.

Nov 21   Lars Pernebo: Algebraic design theory for
            linear multivariable systems. Stanford Univ,
            Stanford, California, USA.

Nov 21   K J Åström: Self-tuning regulators - Design
            principle and applications. Univ of Leuven,
            Belgium.

Nov 22   K J Åström: Self-tuning regulators - Theory.
            Univ of Leuven, Belgium.

Nov 23   K J Åström: State of the art of system iden-
            tification. Univ of Brussel, Belgium.

Nov 29   G Olsson: Control of wastewater treatment
            plants - a survey (in Swedish). Swedish sec-
            tion of Water Pollution Control Federation,
            Stockholm, Sweden.

Dec 1   G Olsson: Swedish experiences of instrumenta-
            tion and control in wastewater treatment
            plants. Institute Recherche Chimie Applique,
            Paris, France.

Dec 5   K J Åström: A survey of adaptive control.
            LAAS, Toulouse, France.

Dec 5   K J Åström: Design of self-tuning regulators.
            CERT/DERA, Toulouse, France.

Dec 7   K J Åström: Adaptive regulators based on
            pole placement design. Univ of Grenoble,
            Grenoble, France.

Dec 12   K J Åström: Piece-wise deterministic signals.
            Int Symp on System Optimization Analysis,
            IRIA, Rocquencourt, France.

1979

Jan 9   K J Åström: Adaptive autopilots for ship steering. Univ of California, Los Angeles, USA.

Jan 10   K J Åström: Reflections on theory and practice of automatic control. Invited keynote lecture 17th decision and control conference, San Diego, USA.

Jan 15   K J Åström: Self-tuning regulators design principles and applications. Univ of Southern California, Los Angeles, USA.

Jan 17   K J Åström: Self-tuning control of a fixed bed chemical reactor. Dept of Chemical Engineering, Univ of California, Santa Barbara, USA.

Jan 19   K J Åström: Self-tuning regulators based on pole placement design. Univ of California, Berkeley, USA.

Jan 22   K J Åström: Principles of adaptive control. Stanford University, USA.

Feb-March   Lars Pernebo: Polynomial matrices and system theory. A series of lectures at University of Southern California, Los Angeles, USA.

April 6   Sven Erik Mattsson: Implementation of Concurrent Pascal. ETH, Zürich, Switzerland.

April 27   K J Åström: Syntes av observerare och regulatorer genom polynommanipulation (Synthesis of observers and regulators using polynomial manipulation), Inst för Optimeringslära och Systemteori, KTH, Stockholm, Sweden.

May 5   Lars Pernebo: Algebraic design theory for linear multivariable systems. University of California, Berkeley, USA.

May 28--29   Ivar Gustavsson: Presentation and demonstration of IDPAC. Teknicum, Uppsala, Sweden.

June 1   Per Molander: Styrning av tekniska system (Control of technical systems). SOAF Conference, KTH, Stockholm, Sweden.

APPENDIX F - TRAVELS

Karl Johan Åström visited Australia in August-September, 1977, where he lectured at University of Queensland, University of New South Wales, and Australian National University. October 3-5, 1977, he participated at the meeting in Düsseldorf of the International Program Committee for the 1978 IFAC World Congress. From December 5, 1977, to January 28, 1978, he visited Imperial College, London. He participated in the IFAC World Congress in Helsinki, June 12-16, 1978. In September, 1978, he lectured at several universities in USA and attended an international symposium on process control for the pulp and paper industries in Monterey, California, USA. On December 12, 1978, he presented a paper at the International symposium on system optimization analysis, IRIA, Rocquencourt, France. He presented a key note lecture at the 17th CDC in San Diego, USA, in January 1979.

Hilding Elmqvist visited the Computer Science Department at Stanford University, California, during the period Aug 15, 1978 - Aug 15, 1979. The time was shared between attending courses, working in a compiler project concerned with extensions to Pascal, and own research mainly consisting of design of language features for description of man-machine interaction.

Per-Olof Gutman has been at the Engineering Systems and the Systems Science Departments, University of California, Los Angeles, as an exchange student during the academic years 1976-78. The main topic of the studies has been biological applications of automatic control. A MSc Engineering degree was achieved in June 1977. Gutman has been lecturing an undergraduate course "Patterns of problem solving" during 1977-78. During the stay in USA he has been visiting numerous universities, industries, and conferences, e.g. Stanford University, NASA Edwards Air Force Base, Measurex Corporation, Capertino Calif, and the Joint Automatic Control Conference in San Francisco, June 1977.

Per Hagander visited the VIIe Colloque International du College de France sur le Théme:"L'Idée de Régulation dans le Mouvement des Sciences" in Paris, December 5-10, 1977. He also attended a symposium on Software for Numerical Optimization, held in London March 10-12, 1978.

Claes Källström visited the division of ship hydro-
dynamics, the Norwegian Institute of Technology (NTH)
in Trondheim on September 25-29, 1977, giving a lecture
in a course on Maneuvering of Marine Structures. He
visitied NTH again on October 4-5, 1977, this time at
the Division of Engineering Cybernetics to give lec-
tures at a course on Interactive programs. Finally he
attended the IFAC World Congress in Helsinki, Finland,
June 1978, and presented a paper.

Sven Erik Mattsson attended an informative meeting
"Ada = Strawman - Konman - Dodula" (The U.S. Department
of Defense Common High Order Language program) arranged
by FOA (National Defense Research Institute) in Stock-
holm, January 30, 1979. He also attended the course
"The Programming Language Pearl" in Studsvik, January
31 - February 1, 1979. He participated in "European Work-
shop on Industrial Computer Systems", Perdue Europe
Regional Meeting, Zürich, Switzerland, April 3-5, 1979.
In connection to that he visited "Fachgruppe für Auto-
matik", ETH, Zürich.

Per Molander spent the academic year Sep 1977 - May
1978 at the Department of Mathematics, Division of Sys-
tems Theory at the Groningen University, Netherlands.
He was joining the research group with Professor J C
Willems.

Gustaf Olsson was invited to the University of Houston,
Texas, USA, during June and July 1977 as a visiting
scientist. In March 1978 he spent a week at different
institutions in England. He visited Thames Water Author
Authority in London, Water Research Centre in Steven-
age, and the Whitlingham sewage treatment plant in
Norwich. On May 16-18, 1978, he participated in a meet-
ing called International Environmental Colloquium in
Liége, Belgium, and presented an invited paper. In June
1978 he attended the IFAC World Congress in Helsinki.
He was invited to the University of Houston, Texas, as
a guest scientist during July and August 1978. On
December 1-2, 1978, he was invited to lecture at an
international course on wastewater treatment control,
arranged by the Institute Recherche Chimie Applique in
Paris. In May 1979 he was invited to the International
Environmental Colloquium in Liége, Belgium, to present
a paper.

Lars Pernebo visited the USA from September 12, 1978,
to September 28, 1979. From Sep 12, 1978, to July 1,
1979, he worked with Prof Silverman's group at Univ of
Southern California, Los Angeles, California. The
research included investigation of balanced state space
representations and model reduction procedures. He
visited the Information Systems Laboratory at Stanford

University, Stanford, California, between Nov 15 and 23,
1978, and between May 28 and 30, 1979. He also visited
the Department of Electrical Engineering at Univ of
California at Berkeley, California, on May 25, 1979.
Between Jan 10 and 12, 1979, he participated in the CDC
conference in San Diego, California.

Jan Sternby attended the IFAC World Congress in Hels-
inki, June 1978, and presented a paper.

Björn Wittenmark spent the academic year at the Univ of
Connecticut, USA, as a visiting professor. During the
year he made several visits to other universities,
industries, and conferences. He attended the IEEE
conference on control and decision in New Orleans,
December 1977. He also made visits to Honeywell, Min-
neapolis, Univ of Massachusetts, Amherst, Case Western
Reserve University, Cleveland, Univ of Minnesota, Min-
neapolis, Rensselaer Polytechnic Institute, Troy, Iowa
State University, Ames, McGill University, Montreal,
Yale University, New Haven. He also attended a sympo-
sium on simulation, modeling and decision in energy
systems, Montreal, Canada.