LUND UNIVERSITY

Travel Report -- A Year in the United States

Mårtensson, Bengt

1984

Document Version:
Publisher's PDF, also known as Version of record

Link to publication

Citation for published version (APA):
Mårtensson, B. (1984). *Travel Report -- A Year in the United States*. (Travel Reports TFRT-8041). Department of Automatic Control, Lund Institute of Technology (LTH).

Total number of authors:
1

General rights
Unless other specific re-use rights are stated the following general rights apply:
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.
• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: https://creativecommons.org/licenses/

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

LUND UNIVERSITY

PO Box 117
221 00 Lund
+46 46-222 00 00

CODEN:LUTFD2/(TFRT-8041)/1-27/(1984)

TRAVEL REPORT: A YEAR IN THE UNITED STATES

BENGT MÅRTENSSON

DEPARTMENT OF AUTOMATIC CONTROL
LUND INSTITUTE OF TECHNOLOGY
JULY 1984

LUND INSTITUTE OF TECHNOLOGY
DEPARTMENT OF AUTOMATIC CONTROL
Box 725
S 220 07 Lund 7 Sweden

Document name
Travel Report

Date of issue
July 3, 1984

Document number
LUTFD2/(TFRT-8041)/1-27/(1984)

Author(s)
Bengt Mårtensson

Supervisor

Sponsoring organization

Title and subtitle

Travel report: A Year in the United States

Abstract

Abstract:
I have spent a year as a graduate student at Harvard University. Essentially, I have been taking courses, some at MIT. After the spring term I attended the American Control Conference (ACC) in San Diego June 6-8, and visited the following institutions: Rensellear Polytechnic Institute (RPI), Washington University in S:t Louis, University of Illinois at Champagne-Urbana, Stanford University, University of California at Santa Barbara (UCSB). Some experiences and tips for future travelers are given. Everything else in life that is important is commented upon.

Key words

Classification system and/or index terms (if any)

Supplementary bibliographical information

ISSN and key title

ISBN

Language
English

Number of pages
27

Recipient's notes

Security classification

DOKUMENTDATABLAD RT 3/81

Distribution: The report may be ordered from the Department of Automatic Control or borrowed through the University Library 2, Box 1010, S-221 03 Lund, Sweden, Telex: 33248 lubbis lund.

TRAVEL REPORT:

A YEAR IN THE UNITED STATES

Bengt Mårtensson

Abstract:
I have spent a year as a graduate student at Harvard University. Essentially, I have been taking courses, some at MIT. After the spring term I attended the American Control Conference (ACC) in San Diego June 6-8, and visited the following institutions: Rensellear Polytechnic Institute (RPI), Washington University in S:t Louis, University of Illinois at Champagne-Urbana, Stanford University, University of California at Santa Barbara (UCSB). Some experiences and tips for future travelers are given. Everything else in life that is important is commented upon.

1. Introduction

This travel report covers my stay in the United States September 1983 - June 1984.

I have spent the academic year 1983 - 1984 in Cambridge, Massachusetts, as a graduate student at Harvard University. Essentially, I have been taking courses. I have also been taking courses at Massachusetts Institute of Technology.

After the spring term I left Cambridge for a long travel through the whole continent. I attended the American Control Conference (ACC) in San Diego June 6-8, and visited a number of different institutions: Rensellear Polytechnic Institute (RPI) in Troy, New York, Washington University in S:t Louis, University of Illinois at Champaigne-Urbana, Stanford University, and University of California at Santa Barbara (UCSB).

This travel report serves several different purposes. First, it is a report to the institutions which have supported me with scholarships, mentioned at the end of this section. Secondly, it is a report to the department of Automatic Control in Lund. I have also included a number of experiences and tips which hopefully can be of value for future travelers. Finally, I have not been able to resist the temptation to include comments on a number of things that has made life a little less pleasant than it could be.

The report is organized in the following manner: In the next two sections my experiences from Harvard and MIT are reported, from essentially an academic point of view. The following sections describe my stay at the different institutions I visited. The ACC-conference is dealt with in section 8. My personal comments and feelings have been concentrated to section 10 and 11. The latter is hoped to contain information pertinent to future travelers. Two appendices contain a listing of the courses I have been taking for credit, and the program of the ACC-conference.

To make a project like this possible and rewarding is nothing you can do just on your own. Unless you have quite a fortune the cost is simply prohibitive, especially right now with the slightly pervert dollar exchange rate. I am very grateful to acknowledge the following support: Lund University has provided me with "utbildningsbidrag för doktorander". It has also covered travel expenses after leaving Cambridge. I also have received scholarships and grants from the following institutions: Harvard University (waiver of tuition fees), The Sweden - America Foundation (30 000 SEK), The Foundation Blancheflor Boncompagni - Ludovisi, nee Bildt (25 000 SEK), The Fulbright Commission (7000 SEK), and "Landshövdingen Per Westlins minnesfond" (2000 SEK).

Money is a necessary, but absolutely not sufficient condition for a rewarding stay and travel. My advisor at the Department of Automatic Control in Lund, Prof. Karl Johan Åström, has taken several contacts and written many introduction letters for me. His encouragement and moral support has been very valuable for me, especially at times when I did not feel very comfortable at Harvard.

Finally, I have to mention my friend and real adviser at Harvard, Prof. Chris

I. Byrnes. When I meet Chris it was like if he was the first and only person in Cambridge who dared to believe in me. We have had many inspiring and rewarding times together, both inside and outside Harvard. I really hope to be able to keep a close contact also in the future.

2. Harvard University

In this section some courses at Harvard, which I have either taken for credit or audited, wholly or in part, will be described.

Courses with number between 100 - 199 are classified as "for graduates and undergraduates", while courses with number 200 - 299 are "primarily for graduates". 300 - numbered courses are individual courses of reading or research for your adviser.

Roger W. Brockett: Nonlinear Control, ES 209, fall semester 1983

This course was an introduction to the differential geometric approach to nonlinear control. A global description of a control system on a manifold as a section of a certain vector bundle was introduced. Questions about nonlinear controllability and observability was discussed. Lie Algebra methods were used in the analysis. Input-output descriptions of nonlinear systems by Volterra series and some results on nonlinear optimal control were covered, together with what has been known as "linearization by feedback".

On the whole, this was an advanced, very stimulation and mind-widening course, leading up to the frontier of todays knowledge. No book on the subject exists, and it is a fairly tough task to try to learn the subject from the available articles. Roger Brockett is a pioneer in the field, and mastered the subject superbly. This course taught me something that I hardly could have learned at another place.

During the Christmas break, while I was back in Sweden, I wrote a term paper "Sampling and Dead-beat Control of Nonlinear Systems". I also gave a seminar at the Department of Automatic Control in Lund on the content of the course. Copies of the viewgraphs (in Swedish) are available at the Department.

There was no final exam.

Rajan Suri: Decision Theory, ES 201, fall semester 1983

This was a course in optimal decisions under uncertainty. The theory is based on concepts such as subjective probability, and utility-function, which is a, eventually subjective, measure which we want to maximize the expected value of. In a sense, decision theory is stochastic control theory without dynamics. Kalman filtering and LQG control were covered. The course tried to cover a very broad scope of applications, both business oriented and more technical. The audience was mixed according to this.

The literature used were DeGroot: "Decision Theory" and Raiffa: "Optimal Statistical Decisions". For a graduate course, I considered the general level (difficulty level, pace etc.) as surprisingly low. I audited the course.

Harvard University

Yu-Chi Ho: Optimal Control, ES 202, fall semester 1983

This is considered as Harvards core course in control theory. Fundamentals on elementary linear system theory (concepts like controllability, observability, and stability) were covered, together with deterministic (optimization in function spaces, Euler - Lagrange's and Hamliton - Jacobi - Bellman's equations) and stochastic optimal control (Kalman filtering and LQG).

Prof. Ho's ambition was to teach the in principle very demanding material on variational calculus to students with an absolute minimum of prerequisites and avoiding "technicalities" as much as possible. The book used (Bryson - Ho: "Applied Optimal Control") is written in much of the same spirit. This is a classical dilemma.

I found the level of the course as very low for a graduate course. I audited the part that dealt with deterministic optimal control.

Michel Rabin: Theory of Computation, CS 121, fall semester 1983

This is considered as a core course in theoretical computer science. It covered basic mathematical techniques for computer science (induction proofs, set theory, "diagonal proofs" etc), finite automata, formal languages, computability, concept free languages, Turing machines, and introduction to complexity theory. The book "Elements of the Theory of Computation" by Lewis - Papadimitriou was used.

This material is, as far as I know, in Sweden considered as very advanced, not too useful (at least for practical purposes), and quite hard. This was not the approach taken here. The difficulty level and the pace were not very high; e. g. several lectures were spent to explain induction proofs and elementary set theory. More than 100 students followed the course, most of which obviously had a very poor mathematical background. But, most interesting, at Harvard they do teach the computer scientists mathematical rigor, and they do it at a very early stage!

I audited the course.

Chris I. Byrnes: Mathematical Topics in Control Theory and Computer Science, AM 343, fall semester 1983

This was a reading course I took for Chris Byrnes during the fall semester. I read papers and books mostly on the subjects of linear system theory. E. g.: high gain feedback as a compactification of the space of finite gains (a Grassman manifold). Geometric methods on the pole placement map (static output feedback). Algebraic geometry. Almost A,B-invariant subspaces.

All this was very stimulating and inspiring for me.

Harvard University

Roger W. Brockett: Stochastic Control, ES203, spring semester 1984

The course started by introducing stochastic differential equations, driven by Poisson counters or Wiener processes. Prof. Brockett claimed that just a short time ago this was considered as "just slightly easier than general relativity", but nowadays it is not at all that hard. His development was at least partially new for me, and he (nearly!) succeeded to give the whole course without ever saying the word "measurable"!

Stochastic modelling was covered, both with jump processes and with the standard linear Ito model $dx = Ax\,dt + Bdw$; $dy = Cx\,dt + dv$.

Then the fun started: Nonlinear estimation and filtering in much of the same framework as the course in nonlinear control. This was new to me and very inspiring.

The course ended by deriving LQG-control from the general framework.

I wrote a term paper "Some Simple Thoughts on a Simple Lie Algebra". There was also a three hour final exam.

Chris I. Byrnes: Linear Systems, ES 204, spring semester 1984

The course started with some discussion on stability of the system $\dot{x} = Ax + Bu$, and methods for determining the number of zeros of a polynomial in the right half plane, leading up to the Hermite - Hurwitz theorem. This is closely related to the more well known methods by Routh and Hurwitz. Different representations of a linear system were covered along with geometric concepts such as A,B-invariant subspaces. Other subjects covered included: pole placement by state feedback for single input and multi input systems (Heymann's lemma), pole placement and stabilization of systems depending on a parameter, pole placement by output feedback, the (possibly infinite) gain as a linear subspace, or more precisely as an element in Grass(p,m+p). Root locus for multi input-multi output systems was covered in some detail. The pole placement map was analysed using methods of algebraic geometry. The use of algebraic geometry was also demonstrated is some problems arising from the analysis of simple power systems.

Adaptive control by output feedback using high-gain feedback methods was discussed. This arose in a sense as an application of the root locus results. The simplest example is $\dot{y} = ay + bu$; where $b > 0$ and the controller $u = -kx$; $\dot{k} = y^2$ is used. This was extended to the case where sign b is unknown, see the paper by Byrnes and Willems in the proceedings of the sixth international conference on analysis and optimization of systems, Nice 1984.

This course was Prof. Byrnes pride. His enthusiasm for the material was absolutely unmistakable. (E. g. it always prevented him from finishing in time.) It was an exciting, advanced, reasonably fast paced course which took the students to the frontier of research on linear system theory. Needless to say, this was an absolutely unique course. Partly because of the advanced character of the material, I sometimes felt the material slightly unorganized. Also, I felt the difference in the students prerequisites as a problem.

For this course and/or the course described immediately below, I wrote two

term papers: "Adaptive control as a search problem", and "A Conjecture on Stability of Linear Time Varying Systems with Application to Adaptive Control".

There was no final exam.

Chris I. Byrnes: Mathematical Topics in Control Theory and Computer Science, AM 343, spring semester 1984

This was a reading course as described above. I read texts on Galois theory and its applications in linear system theory, systems defined on Banach and Frechet algebras, Pernebo's articles on "generalized polynomials", and its use in linear, frequency domain control theory. I also did some work on adaptive control.

Roger Brockett's robotics laboratory

Prof. Brockett has a very strong interest in robotics and the theoretical problems associated. He has been able to get together a robotics lab with e. g. a Cartesian robot arm and vision equipment from Automatix, and an Eclipse MV 10000 mainframe computer from Data General. They want to use the lab for investigating problems such as robot control, image processing with applications to control etc.

It will be very interesting to see what will come out of this in the future. Personally, I consider the lack of professionals to help in handling and maintenance of the equipment as a problem. I have also some difficulties to understand their enthusiasm for Fortran, Fortran programming and programming methodologies common when Fortran was the programming language. Nowadays so very much more powerful ways of solving problems on computers exists, e. g. interactive program packages.

3. Massachusetts Institute of Technology

To get from Harvard to MIT on bike takes just 10 minutes (and ice cold nerves for the Cambridge traffic!). There is a possibility to cross register and take courses at MIT as a regular student. I have been taking the three courses listed below, all of which on graduate level.

David Vogan: Introduction to Lie Groups, 18.755, fall semester 1983

This course started with concepts in elementary differential geometry. Definition, examples and properties of a Lie groups and its associated Lie Algebra were given. The compact Lie groups and their classification were carried out.

No text was used. The final was replaced by homework.

MIT

Sigurdur Helgason: Introduction to Lie Algebras, 18.745, spring semester 1984

This course was in a sense a continuation of the one above. Prof. Helgason followed his book "Differential Geometry, Lie Groups, and Symmetric Spaces" rather closely. Subject covered included compact Lie algebras, the structure theory for semisimple Lie algebras over C, classification of the simple Lie algebras over C, existence theorem on the exceptional algebras, structure theory for semisimple Lie algebras over R. The course ended with a short introduction to representation theory for Lie algebras.

There was homework and no final. We gave a 45 minute seminar each; mine was entitled "Lie Algebras in Control Theory".

Michel Athans - Gunter Stein: Multivariable Control Systems, 6.232, spring semester 1984

This course covered classical and modern synthesis methods for control systems, from the MIT horizon. The course started by devoting fairly much time to standard, classical SISO design, e. g. SISO root locus. Robustness issues were discussed. Singular values of a matrix, especially a transfer function matrix, was used to formulate robustness criteria, and specify required performance for multi input - multi output systems. The most interesting and unique part of the course dealt with what they are calling LQG/LTR design. This is a way of using the nice properties of the LQG design in quite a different way from the "classical". Prof. Athans stressed heavily that design methods based on the theory of optimal control should not be considered as "the best controller", but instead it gives us different design parameters, hopefully easier to tune in order to achieve the desired performance of our control system.

LQG/LTR uses the same regulator structure as the standard LQG regulator, and actually contains it as a special case. However, the interpretation of the noise covariance matrices and the weighting matrices is fundamentally different from standard LQG.

One of the two possible versions of LQG/LTR, aimed at robustness at the plant output, works like this: In some way we find a "Kalman filter gain" H, such that the "open loop Kalman filter transfer function" $C(sI - A)^{-1}H$ (in standard linear systems notation) fulfills the specifications for the open loop transfer function, e. g. as requirements on the singular values as a function of the frequency (i. e. for $s = i\omega$). Then we use "cheap control" ideas, i. e. let the weighting of the control $\to 0$ in the LQ regulator. If the plant is minimum phase, the overall open loop transfer function will approach the above designed "open loop Kalman filter transfer function" ("is recovered", which explains the name LTR, Loop Transfer Recovery). Hence we are considering the "noise covariance matrix" not as something given to us by the problem, but as a design parameter.

The other version of LQG/LTR is aimed at robustness at the plant input and interchanges the role of the noise covariance and weighting matrices, cheap control and "accurate measurements".

On the whole, the problem of design of multivariable control system is very much the problem of how to in a "smart" way reduce the very large number of

degrees of freedom in the controller design down to a very small number, say one, two, or at most three, "knobs" which have easy interpretations, and are easy to tune. LQG/LTR is an interesting attempt, which is said to do very well in practical applications. It tends to give a fairly high order controller, especially if we have introduced integrators in the loop. Prof. Athans stressed that, provided that it is computationally possible, it is better to do the design on the full model, end up with a very high order regulator, and then simplify the regulator, than to do the design on a simplified model.

Despite the two names in the heading, this was essentially Michel Athans' one man show. The last lecture was given by Prof. Austin Spang.

It is obvious that the control group at MIT have a very close contact with applications, at least applications that flies in the air. Their perspective on applications and e. g. on optimal control, described above, did not seem very novel to me with my background, but it might be more uncommon at some places in the U. S. (The teaching assistant on the course told me several times that "it is good for theoreticians like you to learn some practical stuff"! Personally, I have the feeling that a randomly picked person involved in control theory knows exactly one meaning of "PID", either an algebraic object or a regulator.)

The course contained a vast amount of homework, mostly computer aided design, done on the design package Honey-X from Honeywell. Most of it can be characterized as "more transpiration than inspiration". The computer access, the waiting for the printouts, and the response times (especially before 2 am) was a never ending source of irritation. Personally, I felt the volume of the homework rather prevented me than helped me to learn the concepts of the course. A large number of students, 40 - 50, followed the course, many of them from aeronautics - astronautics. This might explain some of the cook-book feeling the course sometimes gave me. I also considered the pace on the lectures as rather slow.

We had access to fairly well written class notes. These also contained some interesting material that was never covered in class.

The final was replaced by the homework.

4. Rensellear Polytechnic Institute

On May 23 I visited Department of Electrical, Computer and Systems Engineering at Rensellear Polytechnic Institute in Troy, New York. First I meet Prof. Dean Frederick, who showed me a very great hospitality, for which I am very thankful.

I had very interesting discussions with Prof. Frederick on computer applications in control theory and computer aided design. I was also showed several programs developed by his students. There seemed to be an emphasis on programs for undergraduate education, e. g. to illustrate the concept of convolution between functions, or the stabilization of an inverted pendulum on a car.

The same day I also meet Prof. George Saridis, who told me about his work on "intelligent machines". A basic idea is to build the intelligent machine as a

hierarchy of several different, interacting layers of increasing intelligence and decreasing precision, each of which is trying to optimize its own goals. He has been working on the viewing of control performance as an entropy, claimed to be an integrated theory for intelligent machines. (He told me he had had some trouble to get that published, because the reviewers considered it as too enthusiastic!) Prof. Saridis also showed me the robotics laboratory, where they tried to put some of these ideas into reallity.

It was very interesting for me to meet Prof. Saridis. His enthusiasm and "wild ideas", which I felt made contact with much of my own thinking, made the talk very inspiring. The area of intelligent machines etc. is much too theoretically interesting to be left to theory less AI-people!

5. Washington University in S:t Louis

On May 28 I left Cambridge "for good" for a, both in time and space, long travel. At arrival in S:t Louis I immediately felt that I was out of Cambridge: three students from the Department of System Science and Mathematics meet me at the airport, and we spent a very nice night in S:t Louis together!

During the time I spent at Washington University, May 29, 31 and June 1, I had the opportunity to have many long and rewarding talks with several different people, both professors and students.

Prof. John Zaborsky and some of his students told me about their work on power systems. I was maybe a bit unprepared for this, but they sure taught me something about the problems.

Prof. Bijoy Ghosh (who is an ex-student of Chris Byrnes!) and I had several long and interesting discussions on linear system theory: high-gain feedback (static and dynamic), adaptive control, stabilization and pole placement of multimode linear system, topology on the space of linear systems, etc. etc.

Prof. Garng M. Huang told me about his work on controllability of quantum-mechanical systems. To bring two of the most exciting fields in which modern, advanced mathematics is used, viz. quantum mechanics and control theory, together in a synthesis is really a wild and beautiful idea!

I also had several rewarding talks with students working on application of feedback linearization to robotics, computational efficiency on real time optimization in power systems. Unfortunately, several interesting persons at the department were away during my stay. My three-day stay was clearly three times as rewarding as a one-day stay. The "social activities" was great, and I had a very good time in S:t Louis together with all the nice people at the department, especially Alain Roquet.

6. University of Illinois at Champaign-Urbana

On May 30 I visited Coordinated Science Laboratory at University of Illinois. I had interesting discussions with Prof. Peter Kokotovic and his students. I got the impression that they had a very interesting, "mature", approach to the relationship between theory and practice (this interplay that I personally consider so fundamental in making control theory to the really fascinating

subject it is).

I talked with people involved in robust adaptive control, identification, thermodynamics, and computer aided design.

7. Stanford University

On June 4 I visited Information Systems Laboratory at Stanford University. I had an interesting discussion with Prof. Gene Franklin, especially on digital control. He also showed me their lab, in which most of their PhD theses are done as projects. It seemed to me as if they had better laboratory resources, especially access to professional technicians, than at the other places I saw.

The "generic" PhD project here consists of a task of the type "find a feasible controller for this funny laboratory process", which could be e. g. a flexible robot arm or a robot arm attached to a "model space shuttle" evolving in two spacial dimensions instead of three (i. e. as a hovercraft). If something of theoretical importance comes out of it it is nice, but that is not the main point. This made me a little disappointed.

I can't resist writing it: Stanford has the nicest "coffee house" I have ever seen on a campus. They even serve wine there!

8. The 1984 American Control Conference in San Diego

The ACC conference took place on June 6 - 8 at Hyatt Islandia Hotel in San Diego. It feels hard to write anything sensible on a conference like this, with 10 or 11 different sessions going on simultaneously. However, I have some personal reflections:

I got the impression that remarkably few really new results were presented, compared to the volume of the talks and the proceedings. Many of the invited talks seemed to me to be just a (fairly superficial) introduction to something the speaker had been working on for some time, based on several years old results. If you knew something of the speaker and the topic of the talk, it felt like there was nothing to be gained from listening to the talk.

During the last years the ACC conference has tried to be more geared towards industry and applications, and less academic. It seems to me as the talks under this category often tend to be somewhat of: "We tried to do this with this microprocessor and it did not work very well. Then we used a faster microprocessor instead, and it worked beautifully." This is probably important for the people involved in that very area, but it does not seem to contain very much of universal wisdom.

The session on Friday afternoon on robust adaptive control was interesting. The subject has been very intensely (and emotionally!) discussed during the last few years. It can be expected that several in the audience came to witness great quarrels. They got at least partially satisfied.

Some time ago, people came to the conferences and told that they had been able to get a certain adaptive algorithm to flip out completely. The talks now were actually much more constructive; a general theme was the analysis of

the different ways the adaptive algorithms had flipped out, and proposals of fixes.

Originally I had planned to travel for a much longer time: two more weeks in California, visiting Berkeley and Prof. Charles Desoer, University of Southern California and Prof. Leonard Silverman, Santa Barbara and Prof. Alan Laub. Then, the 25, I planned to spend a week in New York, visiting General Electric in Schenectady and Dr. John Cassidy, and Bell Labs. For different reasons, I had to shorten down the trip and cancel most of these plans. However, I hope to make these visits in a not too distant future.

9. University of California at Santa Barbara

On June 14 I showed up at Department of Electrical and Computer Engineering at University of California at Santa Barbara, without having told anyone in advance. I had a nice talk with Prof. Ian Rhodes.

10. Personal experiences and comments on Harvard and Cambridge

In many respects, taking graduate courses at Harvard differs very much from what I have been used to in Sweden. A particular course is in general very intimately connected to a certain professor, who gives "his course" year after year, unless he is absent that year, in which case that course is not given. "No" professor with self-respect ever lectures a book somebody else has written; if he has not (yet?) written a book emerging from the course, no text is used, or the text is just used as a reference.

It is in general very hard to tell from the course bulletin if a certain course is an interesting, advanced, unique course, or if it just contains material that you to a large extent learned at high school. I got the impression that even on courses that were considered as advanced, the level at the beginning was often surprisingly elementary. Homework assignments for every week are very common. It is sometimes graded, sometimes not. They sometimes seem to consider it as necessary for developing good working habits among the students. The common mid-term exams have to be explained in the same way.

Term papers are fairly common and eventually replaces the final exam. The finals are always three hour written exams, which to me hardly seems to allow anything more than superficial tests. The only final I took, the one in stochastic control, was done on a "writing desk" approximately 15 x 15 cm!!

On the whole, the general situation and status for a PhD candidate is fundamentally different. A PhD candidate is just a student as the undergraduates, a kid just on his way of becoming an adult. I got the impression that the theses were done with the student very much like a "research slave" - the cheapest labor available - for his professor. The material resources a PhD candidate has access to, even at "big schools" such as Harvard and MIT, are surprisingly small. Don't ever dream about your own office until you have your PhD. At Harvard I had a desk, together with several other students, in a huge room (which we called "the dungeon") in the basement of Pierce Hall. There was one telephone common for three shared

student offices with approximately 15 students.

Decent computer access is not at all considered as something obvious, at least not at Harvard ("you'll get computer access when you need it").

To get all the practical things in a laboratory running, even such things as a mainframe computer, is generally totally dependent of the graduate students, with no help from professionals. There are two different reasons for this: Often it is a resource problem, but most importantly, this is most often not recognized as a problem: it is considered as a part of the training to learn how to solve practical problems!

As a general impression, I found Cambridge and especially Harvard as a fairly cold and unfriendly place. I hardly found a single person who told me that he really enjoyed Harvard University. It seems as if it, and the people who identify themselves with Harvard, is clearly convinced that this is The Greatest University on Earth, and the students should be awfully thankful to be allowed to come to this divine place, just next-doors to God himself.

11. Some tips for future travelers

Diplomas etc: The requirements on all the papers you have to send to apply to an U. S. institution are simply amazing. Apart from this, the translation of the Swedish diplomas is quite a time consuming task. Lund Institute of Technology, which is a more than 20 year old institution, still do not know how to translate its diplomas to English! (At least this was the case last year.)

Insurances: The health service at Harvard University forces you to take their "Blue Cross - Blue Shield" insurance for approximately 300 dollars, unless you have an approved, U. S based insurance plan. Foreign based insurances are not accepted. (Does there exist anything relyable outside the U. S.?) It feels hard to find a justification for this maffia-like behavior (no one ever tried to do this to me), but future travelers should be aware and find out if their university shows the same kind of hospitality, before they buy an insurance in Sweden.

Housing: The housing situation on many places, e. g. Cambridge, is really tough. If you are planning to start studies to the fall, it is not too early to start looking for a place to stay in the middle of the spring. Applications for graduate dormitories at Harvard are due in April. Don't be caught by surprise!

Banking: I have a very bad experience of U. S. banks. Since nothing like the postal giro exists, you have to have a checking account. These are not very profitable: Most often they have low interest, high fees and/or minimum balance. According to my experiences, the U. S. banking system is also hoplessly inefficient. Find out the best ways of making transfers from funds in Sweden to bank accounts in the U. S. in advance!

Credit cards: Credit cards are an exception that works fairly well. It is possible, however not likely, that you can rent a car without one. They also greatly simplify life if you ever are going to order anything by mail in the U. S. Mastercard and Visa are accepted on 99.9 % of all places that accept

any credit card; American Express is clearly number three. I never had any problems with using Eurocard as Mastercard. The rest is not very widely accepted.

Due to several unreasonable delays by the banks, especially Bay Bank in Cambridge, I have my credit cards to thank for the existence of section 4 - 9 in this report.

Appendix 1. Passed courses

Institution/ Course name

Graduate Courses at Harvard University:

Nonlinear Control, ES209
"Asc. Prof. C. I. Byrnes", AM343
Linear Systems, ES204
Stochastic control, ES203
"Asc. Prof. C. I. Byrnes", AM343

Graduate Courses at Massachusetts Institute of Technology:

Intro. to Lie Groups, 18.755
Intro. to Lie Algebras, 18.745
Multivariable Control Systems, 6.232

Appendix 2. Program for the ACC conference

SESSION =	1	2	3	4	5	6	7	8	9	10	11
Room / Starting Time	MERMAID	REGENCY-B	REGENCY-C	ISLANDS-A	ISLANDS-B	DOLPHIN	SANDPIPER	SEAGULL	PENGUIN	MARLIN	REGENCY-A
8:30			Plenary Speaker Robert A. Frosch Regency Room Getting It All Under Control								
WA 9:45	Modelling of Human Cognitive Decision Processes (I)	Sensor Based Robot Control Systems (I)	Adaptive Control and Applications I (I)	Modelling and Simulation of Thermofluid Processes and Systems (I)	Advanced Concepts for Computer-Aided Control System Design (I)	Model Reduction and Large Scale Systems (I)	Fuel-Optimal Aircraft Guidance and Control (I)	AI Applications to Control Systems (I)	Digital Signal Processing (I)	Dynamical Systems Approach to Problems in Nonlinear Systems (I)	
WP 2:30	Monitoring and Fault Detection in Power Systems	Robot Path Planning & Control	Adaptive Control Theory & Applications	Real Time Control of Processes (I)	Pole Placement Design	Large Scale Systems & Model Reduction (I)	Aircraft Control	Servomechanisms and Machine Tool Control	Stochastic Systems	Process Model-Based Control and Analysis (I)	
WE 7:00 P.M.	WE1: ISLANDS-A Microprocessor Implementation of Control Systems (I) WE2: ISLANDS-B Control Engineering for Energy Conservation (I)										
TA 8:30	Multitarget Tracking (I)	Robot and Manipulator Dynamics	Industrial Process Control (I)	Predictive Control: Theory and Application to Chemical Processes (I)	Design of Multivariable Systems (I)	Control Experiment for Flexible Structures (I)	Missile Guidance & Control Systems (I)	Automation in Integrated Circuit Manufacturing (I)	Decomposition and Decentralization Techniques	Controller Design for Nonlinear Systems (I)	Power Systems
12:00	Luncheon Speaker Allen R. Stubberud Regency Room A Hard Look at Software										
TP 2:30	Digital Systems	Kinematics, Dynamics & Controller Design for Robotic Systems (I)	Adaptive Control and Applications II (I)	Advanced Control Theory & Applications (I)	Robust Control Design	Modelling & Design by Experimental Modal Analysis (I)	Fluidic Sensors, Control & Interface Components (I)	Control Systems for Manufacturing (I)	Identification and Estimation	Fault-Tolerant Computers in Automation and Process Control (I)	Power System Control (I)
8:30	Plenary Speaker Arthur E. Bryson, Jr. Regency Room New Concepts in Control Theory, 1959–1984										
FA 9:45	Controls in Automotive Systems (I)	Robot and Manipulator Control	Adaptive Control Theory	Robustness Issues in Process Control (I)	Linear Systems	Reduced Order Modelling & Control	Tracking and Missile Control	Multiagent Decision Problems (I)	Filtering and Estimation	Nonlinear Systems	Control Aspects of Electric Power Systems (I)
FP 2:30	Actuators (I)	Dynamic Control of Manipulators (I)	Robust Adaptive Control (I)	Chemical Reactor Control (I)	Optimal Control	Rotational Maneuvers of Flexible Spacecraft (I)	Fluidic Flight Control (I)	Distributed Control (I)	Fault Tolerant Aerospace Systems (I)	Control Applications	Alternate Power Generation, Co-Generation and Energy Recovery Systems (I)

TABLE OF CONTENTS AND PROGRAM

PROGRAM

CODING:
- WA = Wednesday morning
- WP = Wednesday afternoon
- WE = Wednesday evening
- TA = Thursday morning
- TP = Thursday afternoon
- FA = Friday morning
- FP = Friday afternoon
- (I) = Invited Paper

WEDNESDAY MORNING
June 6, 1984

PLENARY SESSION I
8:30-9:30 **Regency Room**

Chair: Herbert E. Rauch, Lockheed Palo Alto Research Lab

Co-Chair: Leonard Shaw, Polytechnic Institute of New York

Keynote Address: Getting It All Under Control
Robert A. Frosch,
Vice President
General Motors Research Laboratories

SESSION WA1: Mermaid
MODELING OF HUMAN COGNITIVE DECISION PROCESSES

Organizer and Chair: D. P. Looze, Alphatech, Inc., Burlington, MA

Co-Chair: D. L. Kleinman, Univ. of Connecticut, Storrs, CT

9:45-10:15 (I)
The Subjective Transfer Function (STF) Approach to Subjective Modeling †
C. T. Veit and M. Callero, The Rand Corp., Santa Monica, CA

10:15-10:45 (I)
The Modeling of Human Cognitive Decision Processes in the Intelligent Machine Model (TIMM*) 1
R. Parker and S. J. Kiselewich, General Research Corp., Santa Barbara, CA

10:45-11:15 (I)
An Application of Value Driven Decision Methods to Control Simulated Combat Pilots †
R. Kerchner, Decision Science Applications, Arlington, VA

11:15-11:45 (I)
A Research Paradigm for Multi-Human Decision Making 6
D. L. Kleinman, D. Serfaty, and P. B. Luh, Univ. of Connecticut, Storrs, CT

11:45-12:15 (I)
ASW Commander Tactical Decision Simulation Model 12
M. G. Alexandridis, J. C. Deckert, E. E. Entin, and J. G. Wohl, Alphatech, Inc., Burlington, MA

12:15-12:45 (I)
Modeling of Human Resource Management in Air Defense Systems †
D. P. Looze and M. P. Kastner, Alphatech, Inc., Burlington, MA

SESSION WA2: Regency B
SENSOR-BASED ROBOT CONTROL SYSTEMS

Organizer and Chair: L. M. Sweet, General Electric Co., Corporate Research and Development, Schenectady, NY

Co-Chair: F. B. Prinz, Carnegie-Mellon Univ., Pittsburgh, PA

9:45-10:15 (I)
An Accuracy Test Procedure for Robotic Manipulators Utilizing a Vision Based, 3-D Position Sensing System 19
R. Podoloff and W. Seering, Massachusetts Institute of Technology, Cambridge, MA; B. Hunter, Automatix, Inc.

10:15-10:45 (I)
Enhancement of Robot Accuracy Using Endpoint Feedback and a Macro-Micro Manipulator System 1836
A. Sharon and D. E. Hardt, Massachusetts Institute of Technology, Cambridge, MA

10:45-11:15 (I)
Structures for Sensor-Based Robot Motion Control 23
M. Good and L. M. Sweet, General Electric Co., Schenectady, NY

11:15-11:45 (I)
Simplified Grasping and Manipulation with Dexterous Robot Hands 32
R. Fearing, Stanford Univ., Stanford, CA

11:45-12:15 (I)
Force Feedback Control in Insertion Process Using Pattern Analysis Techniques 39
C. S. G. Lee and R. H. Smith, Univ. of Michigan, Ann Arbor, MI

12:15-12:30 (I)
Ultrasonic Sensors in Robotic Seam Tracking 45
K. T. Gunnarsson and F. B. Prinz, Carnegie-Mellon Univ., Pittsburgh, PA

SESSION WA3: Regency C
ADAPTIVE CONTROL AND APPLICATIONS-I

Organizer and Chair: G. Dumont, Univ. of British Columbia, Vancouver, BC, CANADA
Co-Chair: D. Seborg, Univ. of California, Santa Barbara, CA

9:45-10:15 (I)
Practical Experience with Kamyr Digester Level Self-Tuning Control 48
P. R. Belanger, McGill Univ., Montreal, Quebec, CANADA; G. A. Dumont and S. Gendron, Univ. of British Columbia, Vancouver, BC, CANADA

10:15-10:45 (I)
A Self-Tuning Strategy for Moisture Control in Papermaking 54
R. F. Sikora, W. L. Bialkowski, J. F. McGregor, and P. A. Taylor, Domtar Inc., Islington, Ontario, CANADA

10:45-11:15 (I)
Experimental Evaluation of Adaptive Control Methods on a Pilot Plant Evaporator 1843
H. K. Song, D. G. Fisher, and S. L. Shah, Univ. of Alberta, Edmonton, Alberta, CANADA

11:15-11:45 (I)
MIMO Self-Tuning Control of Chemical Process Operation 62
L. Hallager, S. B. Jorgensen, and L. Goldschmidt, Technical Univ. of Denmark, Lyngby, DENMARK

11:45-12:15 (I)
Auto-Selection of the Sampling Period for a Class of Pole-Placement Controllers 67
P. E. McDermott and D. A. Mellichamp, Univ. of California, Santa Barbara, CA

12:15-12:45 (I)
Automatic Tuning of PID and Other Simple Regulators in a Digital Process Automation System 74
A. Halme and O. Ahava, Univ. of Oulu, Oulu, FINLAND

SESSION WA4: Islands A
MODELLING AND SIMULATION OF THERMOFLUID PROCESSES AND SYSTEMS

Organizer and Chair: R. Shoureshi, Purdue Univ., West Lafayette, IN
Co-Chair: W. G. Perera, California Engineering Research, Los Angeles, CA

9:45-10:15 (I)
Overpressurization of Process Steam Kettle Reboiler Transients †
A. Yardon, South Western Engineering, Los Angeles, CA; W. G. Perera, California Engineering Research, Los Angeles, CA

10:15-10:45 (I)
A Dynamic Model of a Condenser in a Closed Rankine Cycle Power Plant 79
M. Kapadia and C. H. Wolgemuth, The Pennsylvania State Univ., University Park, PA

10:45-11:15 (I)
THEDA-2 Code Verification with Data from Model Tests of a Once-Through Steam Generator 85
T. E. Moskal, M. T. Childerson, and H. R. Carter, The Babcock and Wilcox Co., Alliance, OH

11:15-11:45 (I)
Modeling and Dynamics of Two-Phase Flow Heat Exchangers Using Temperature-Entropy Bond Graphs 93
R. Shoureshi and K. McLaughlin, Purdue Univ., West Lafayette, IN

11:45-12:15 (I)
Transient Simulation and Experimental Verification of Gas-Steam and Liquid-Steam, Shell, and Tube Type Heat Exchangers 99
K. J. Daniel, A. W. Crapo, and D. H. Brown, General Electric, Schenectady, NY

12:15-12:45 (I)
Frost Bulb Growth With or Without Groundwater Flow on a Buried Chilled Alaskan Pipe 1850
W. G. Perera, California Engineering Research, Los Angeles, CA

SESSION WA5: Islands B
ADVANCED CONCEPTS FOR COMPUTER-AIDED CONTROL SYSTEM DESIGN

Organizer and Chair: J. H. Taylor, General Electric Corp., Research and Development, Schenectady, NY
Co-Chair: D. K. Frederick, Rensselaer Polytechnic Institute, Troy, NY

9:45-10:15 (I)
Parameter Space Design of Control Systems Using Interactive Computer Graphics 105
P. Putz and M. J. Wozny, Rensselaer Polytechnic Institute, Troy, NY

10:15-10:45 (I)
Control Engineer's Workbench-A Methodology for Microcomputer Implementation of Controls 115
H. A. Sutherland and K. L. Sonin, General Electric Corp., Research and Development, Schenectady, NY

10:45-11:15 (I)
Completing the Computer-Aided Control System Design Process †
R. H. Travassos, Systolic Systems Inc., Campbell, CA

11:15-11:45 (I)
System Building in MATRIX$_x$: Interactive Graphical Model Building of Nonlinear Systems for Simulation and Optimization †
D. B. Varvell, S. C. Shah, and C. Z. Gregory, Integrated Systems, Inc., Palo Alto, CA

11:45-12:15 (I)
An Expert System for LQG/LTR Control System Design †
M. Athans, Massachusetts Institute of Technology, Cambridge, MA

12:15-12:45 (I)
An Expert System Scenario for Computer-Aided Control Engineering 120
J. H. Taylor, General Electric Corp., Research and Development, Schenectady, NY; D. K. Frederick, Rensselaer Polytechnic Institute, Troy, NY; J. R. James, U.S. Army and Rensselaer Polytechnic Institute, Troy, NY

SESSION WA6: Dolphin
MODEL REDUCTION AND LARGE SCALE SYSTEMS

Organizer and Chair: U. B. Desai, Washington State Univ., Pullman, WA
Co-Chair: C. S. Hsu, Washington State Univ., Pullman, WA

9:45-10:15 (I)
Hierarchal Optimization of Large-Scale Time-Delay Systems-A Brief Overview 129
M. Jamshidi, Univ. of New Mexico, Albuquerque, NM

10:15-10:45 (I)
Model Reduction in the Presence of Parameter Uncertainty 135
D. A. Wagie and R. E. Skelton, Purdue Univ., West Lafayette, IN

10:45-11:15 (I)
Singular Value Analysis, Balancing, and Model Reduction of Large Space Structures 141
E. A. Jonckheere and P. Opdenacker, Univ. of Southern California, Los Angeles, CA

11:15-11:45 (I)
A Unifying Tool for Comparing Stochastic Realization Algorithms and Model Reduction Techniques 150
J. A. Ramos and E. I. Verriest, Georgia Institute of Technology, Atlanta, GA

11:45-12:15 (I)
Order Reduction Via Multiple Singular Parameters 156
C. S. Hsu, Washington State Univ., Pullman, WA

12:15-12:45 (I)
A Reduced Order Controller: Canonical Correlation Analysis of Deterministic/Stochostic Systems 160
U. B. Desai and S. Banerjee, Washington State Univ., Pullman, WA

SESSION WA7: Sandpiper
FUEL-OPTIMAL AIRCRAFT GUIDANCE AND CONTROL

Organizer and Chair: A. Chakravarty, Boeing Commercial Airplane Co., Seattle, WA
Co-Chair: J. Vagners, Univ. of Washington, Seattle, WA

9:45-10:15 (I)
Concepts and Algorithms for Terminal-Area Traffic Management 166
H. Erzberger and J. D. Chapel, NASA Ames Research Center, Moffett Field, CA

10:15-10:45 (I)
The Flight Planning-Flight Management Connection 174
J. A. Sorensen, Analytical Mechanics Associates, Inc., Mountain View, CA

10:45-11:15 (I)
Application of Cost Index to Fleet Hub Operation 179
M. K. DeJonge, Lear Siegler, Inc., Instrument Div., Grand Rapids, MI; W. H. Syblon, American Airlines, Dallas, TX

11:15-11:45 (I)
Simulation of Time-Control Procedures for the Advanced Air Traffic Control System 185
L. Tobias and P. J. O'Brien, NASA Ames Research Center, Moffett Field, CA

11:45-12:15 (I)
Time-Controlled Aircraft Guidance in Uncertain Winds and Temperatures 191
A. Chakravarty, Boeing Commercial Airplane Co., Seattle, WA; J. W. Burrows, Boeing Computer Services Co., Seattle, WA

12:15-12:45 (I)
Feedback Control for Fuel-Optimal Descents Using Singular Perturbation Techniques 198
D. B. Price, NASA Langley Research Center, Hampton, VA

SESSION WA8: Seagull
AI APPLICATIONS TO CONTROL SYSTEMS

Organizer and Co-Chair: D. S. Joshi, Northrop Corp., Hawthorne, CA
Chair: R. O. Anderson, AFWAL/FIGC, Wright-Patterson AFB, OH

9:45-10:15 (I)
AI Applications Potential: Military Pilot Decision Aiding †
W. G. James, AFWAL/FIGX, Wright-Patterson AFB, OH

10:15-10:45 (I)
An Expert System for Control Law Synthesis in a Battle Damaged Aircraft †
T. L. Trankle, L. A. Markosian, and A. J. Rockmore, Systems Control Technology, Inc., Palo Alto, CA

10:45-11:15 (I)
An Intelligent Robotics Control Scheme 204
N. E. Orlando, NASA Langley Research Center, Hampton, VA

11:15-11:45 (I)
Battle Damage Considerations for Adaptive Flutter Suppression †
D. S. Joshi, R. Robinett, and E. H. Johnson, Northrop Corp., Hawthorne, CA

11:45-12:15 (I)
Flight/Propulsion Control Availability Through Expert System Maintenance †
P. Briggs and F. S. Lynch, General Electric Co., Binghamton, NY

12:15-12:45
Panel Discussion:
Panelists: Session Authors

SESSION WA9: Penguin
DIGITAL SIGNAL PROCESSING

Organizer and Chair: D. M. Etter, Stanford Univ., Stanford, CA
Co-Chair: N. Ahmed, Univ. of New Mexico, Albuquerque, NM

9:45-10:15 (I)
On the Detection and Tracking of a Class of Narrowband Sources 210
N. Ahmed, D. Hush, and S. Park, Univ. of New Mexico, Albuquerque, NM; R. J. Fogler and G. R. Elliott, Sandia National Labs, Albuquerque, NM

10:15-10:45 (I)
Modeling of Two-Dimensional Fields with Autoregressive Lattice Parameters 216
S. R. Parker, Naval Postgraduate School, Monterey, CA

10:45-11:15 (I)
A Parallel Structure for Adaptive Line Enhancement 222
R. A. David, Sandia National Labs, Albuquerque, NM

11:15-11:45 (I)
A Comparison of Methods for Estimating Coherence 228
S. D. Stearns and O. M. Solomon, Sandia National Labs, Albuquerque, NM

11:45-12:15 (I)
Adaptive Delay Tracking with a Varying SNR 234
D. M. Etter, Stanford Univ., Stanford, CA

12:15-12:45
Panel Discussion:
Panelists: Session Authors

SESSION WA10: Marlin
THE DYNAMICAL SYSTEMS APPROACH TO PROBLEMS IN NON-LINEAR SYSTEMS AND CONTROL

Organizer and Chair: S. S. Sastry, Univ. of California, Berkeley, CA
Organizer and Co-Chair: F. M. A. Salam, Drexel Univ., Philadelphia, PA

9:45-10:15 (I)
Bifurcating Equilibria of Adaptive Control Systems 238
B. Riedle and P. Kokotovic, Univ. of Illinois, Urbana, IL

10:15-10:45 (I)
A Comparative Study of Linear and Nonlinear Mimo Feedback Configurations 242
C. A. Desoer and C. A. Lin, Univ. of California, Berkeley, CA

10:45-11:15 (I)
Phase Portrait of the Ricatti Equation From the Periodic Control Problem 250
M. A. Shayman, Washington Univ., St. Louis, MO

11:15-11:45 (I)
Lyapunov Functions for Invariant Sets of Dynamical Systems †
A. Arapostathis, Univ. of Texas, Austin, TX

11:45-12:15 (I)
The Melnikov Technique and Arnold Diffusion for a Class of Perturbed Dissipative Systems 258
F. M. A. Salam, Drexel Univ., Philadelphia, PA

12:15-12:45 (I)
Local and Global Bifurcations in the Dynamics of Circuit and Systems †
S. S. Sastry, Univ. of California, Berkeley, CA

WEDNESDAY AFTERNOON
June 6, 1984

SESSION WP1: Mermaid
MONITORING AND FAULT DETECTION IN POWER SYSTEMS

Chair: J. Purviance, Univ. of Idaho, Moscow, ID

2:30-3:00
A Fault Detection and Isolation Methodology-Theory and Application 262
M. Desai and A. Ray, The Charles Stark Draper Laboratory, Inc., Cambridge, MA

3:00-3:30
Instrument Failure Detection in Nonlinear Systems 271
J. L. Tylee, EG&G Idaho, Inc., Idaho Falls, ID; J. E. Purviance, Univ. of Idaho, Moscow, ID

3:30-4:00
An Informational Scheme for Monitoring of Power Systems Disturbances 274
M. S. Taha, Ministry of Electricity and Energy, Cairo, EGYPT

SESSION WP2: Regency B
ROBOT PATH PLANNING AND CONTROL

Chair: J. F. Cassidy, Jr., General Electric Co., Schenectady, NY
Co-Chair: G. Lee, Univ. of Michigan, Ann Arbor, MI

2:30-3:00
Optimal Control of a Robot With Obstacles 280
M. Niv, Rafael, Haifa, ISRAEL; D. M. Auslander, Univ. of California, Berkeley, CA

3:00-3:30
The Configuration Space Approach to Robot Path Planning 288
W. E. Red, Brigham Young Univ., Provo, UT; V. Truong-Cao, Texas A&M Univ., College Station, TX

3:30-4:00
An Efficient Minimum-Time Robot Path Planning Under Realistic Constraints 296
B. K. Kim and K. G. Shin, The Univ. of Michigan, Ann Arbor, MI

4:00-4:30
Impedance Control: An Approach to Manipulation 304
N. Hogan, Massachusetts Institute of Technology, Cambridge, MA

4:30-5:00
Resolved Motion Adaptive Control for Mechanical Manipulators 314
C. S. G. Lee and B. H. Lee, Univ. of Michigan, Ann Arbor, MI

5:00-5:15
Precise Trajectory Following for Robotic Manipulators 320
S. Jayasuriya, Michigan State Univ., East Lansing, MI; M. A. Zohdy, Oakland Univ., Rochester, MI

SESSION WP3: Regency C

ADAPTIVE CONTROL THEORY AND APPLICATIONS

Chair: H. Elliott, Univ. of Massachusetts, Amherst, MA
Co-Chair: H. Kaufman, Rensselaer Polytechnic Institute, Troy, NY

2:30-3:00
A Globally Stable Adaptive Algorithm for Discrete Time Systems With Fast Unmodeled Dynamics 323
R. Cristi, Univ. of Michigan-Dearborn, Dearborn, MI

3:00-3:30
Assessment and Application of Adaptive Controllers 329
C. K. Goh and P. R. Bunn, Teeside Polytechnic, Middlesbrough, Cleveland, ENGLAND

3:30-3:45
Robust Adaptive Control 333
K. S. Narendra and A. M. Annaswamy, Yale Univ., New Haven, CT

3:45-4:00
Persistent Excitation in Dynamical Systems 336
K. S. Narendra and A. M. Annaswamy, Yale Univ., New Haven, CT

4:00-4:30
Application of a Multivariable Self-Tuning Controller to a Power Plant Boiler 339
M. Amin, G. Y. Masada, and B. F. Womack, Univ. of Texas, Austin, TX

4:30-5:00
A Self-Tuning Controller with Multiple Inputs in the Production of Glass Containers †
I. L. Ayala, Vitro Tec Fideicomiso, Monterrey, Nuevo Leon, MEXICO

SESSION WP4: Islands A

REAL TIME CONTROL OF PROCESSES

Organizer and Chair: N. D. Holder, GA Technologies, San Diego, CA
Co-Chair: J. Martinez-Lara, GA Technologies, San Diego, CA

2:30-3:00 (I)
Process Control in the Paper Industry †
L. Adler, International Paper Co., Tuxedo Park, NY

3:00-3:30 (I)
Convert to Microprocessor Controls Without Shutting Down †
G. Melrose, Marathon Oil, Findlay, OH

3:30-4:00 (I)
Importance of Field Instrumentation Calibration to Effective Real Time Inventory and Process Control †
O. Neesbye-Hanson, Gulf Oil, Houston, TX

4:00-4:30 (I)
Real Time Equipment Condition Diagnostic Monitoring †
J. C. Fitch, Diagnetics, Inc., Tulsa, OK

4:30-5:00 (I)
Alternatives for Implementing Advanced Control Techniques †
C. L. Smith, Cecil C. Smith, Inc., Baton Rouge, LA

5:00-5:30 (I)
On-Line Analyzers, Key to Effective Chemical Process Control 348
M. D. Weiss, Consultant-Lecturer, Ann Arbor, MI

SESSION WP5: Islands B

POLE PLACEMENT DESIGN

Chair: B. A. Francis, Univ. of Waterloo, Waterloo, Ontario, CANADA
Co-Chair: F. L. Lewis, Georgia Institute of Technology, Atlanta, GA

2:30-3:00
Control of Oil-Whirl by Pole Assignment 354
C. R. Burrows and M. N. Sahinkaya, Univ. of Strathclyde, Glasgow, SCOTLAND

3:00-3:30
Eigenvalue Spectra and Bounds for Certain Classes of Dynamic Systems Having Tree Bond Graphs 360
A. Zeid and R. Rosenberg, Michigan State Univ., East Lansing, MI

3:30-4:00
A Result on the Placement of Infinite Eigenvalues in Descriptor Systems 366
K. Ozcaldiran and F. L. Lewis, Georgia Institute of Technology, Atlanta, GA

4:00-4:30
Eigenstructure Assignment by State Feedback 372
M. I-J Chang, Goodyear Aerospace Corp., Akron, OH

4:30-4:45
A New Approach to the Problem of Pole Assignment Through Output Feedback 378
G. E. Sevaston, Rutgers Univ., Piscataway, NJ

4:45-5:00
On the Conceptual Implications of Some Recent Results on Pole Assignment 381
J. Hammer, Case Western Reserve Univ., Cleveland, OH

5:00-5:15
Design of Optimal Low-Sensitivity Controllers with Prespecified Eigenvalues: Application to Aircraft Lateral Motion 384
N. N. Sorial, Alexandria Univ., Alexandria, EGYPT

SESSION WP6: Dolphin

LARGE SCALE SYSTEMS AND MODEL REDUCTION

Organizer and Chair: M. T. Tran, Boeing Co., Wichita, KS
Co-Chair: M. E. Sawan, Wichita State Univ., Wichita, KS

2:30-3:00 (I)
Model Order Reduction of Stochastic Interconnected Systems for Decentralized Control 387
A. K. Mahalanabis, Lehigh Univ., Bethlehem, PA; S. I. Ahson and R. Prasad, Indian Institute of Technology, INDIA

3:00-3:30 (I)
Obtaining Reduced-Order Stochastic Models 393
R. J. Vaccaro, Univ. of Rhode Island, Kingston, RI

3:30-4:00 (I)
A Generalization of the Cover Algorithm for Controller Reduction 397
A. Yousuff, Drexel Univ., Philadelphia, PA

4:00-4:15 (I)
On the Eigenvalue Placement of Discrete-Time Systems with Slow and Fast Modes 399
D. Shah and M. E. Sawan, Wichita State Univ., Wichita, KS; M. T. Tran, Boeing Co., Wichita, KS

4:15-4:30 (I)
Decoupling of Large Scale Systems 401
D. Shah and M. E. Sawan, Wichita State Univ., Wichita, KS; M. T. Tran, Boeing Co., Wichita, KS

4:30-5:00 (I)
Design of Decoupled Longitudinal Flight Control Laws Utilizing Eigensystem Assignment 403
K. M. Sobel and E. Y. Shapiro, Lockheed California Co., Burbank, CA

5:00-5:30 (I)
Adaptive Control Techniques for a Class of Large-Scale Systems 409
P. Ioannou and M. DePonte, Jr., Univ. of Southern California, Los Angeles, CA

SESSION WP7: Sandpiper

AIRCRAFT CONTROL

Chair: D. Andrisani, II, Purdue Univ., West Lafayette, IN
Co-Chair: T. Sadeghi, Fairchild Republic Co., Farmingdale, NY

2:30-3:00
Adaptive Corrective Alignment for a Carouseling Strapdown INS 1856
C. Johnson, Delco Systems Operations, Santa Barbara, CA

3:00-3:30
A Likelihood Function Method for Multiple Aircraft Maneuver Tracking 415
A. W. Warren, Boeing Computer Services Co. Tukwila, WA

3:30-4:00
Selection of Slow and Fast Variables in Three-Dimension Flight Dynamics 423
M. E. Ardema and N. Rajan, NASA-Ames Research Center, Moffett Field, CA

4:00-4:30
A Modern Control Approach to Inertial Instrument Capture Loop Design 428
J. Moore, Delco Systems Operations, Santa Barbara, CA

4:30-5:00
Design of a Pitch Orientation Control System for Aircraft Control in Stall Region 434
M. M. Kulkarni and V. N. Joshi, Indian Institute of Technology, Bombay, INDIA

5:00-5:15
Optimal Nonlinear BTT Control in a CLOS Guidance System 440
D. J. Roddy and G. W. Irwin, Queens Univ. of Belfast, Belfast, N. IRELAND

SESSION WP8: Seagull

SERVOMECHANISMS AND MACHINE TOOL CONTROL

Chair: T. M. Drzewiecki, Science and Technology Associates, Arlington, VA
Co-Chair: P. Houpt, Massachusetts Institute of Technology, Cambridge, MA

2:30-3:00
An Adaptive Control of an Electro-Hydraulic Position Control System 443
M. M. Kulkarni, D. B. Trivedi, and J. Chandrasekhar, Indian Institute of Technology, Bombay, INDIA

3:00-3:30
Digital Control Algorithms for Electrohydraulic Machine Tool Feed Drive Servomechanisms 449
K. Srinivasan and C. Dogan, Ohio State Univ., Columbus, OH

3:30-4:00
Normal Modes in Hydraulic Lines 458
M. Lebrun, I.N.S.A., Villeurbanne, FRANCE

4:00-4:30
On the Development of a Modified On-Off Controller for Pneumatic Servo Mechanisms 468
T. Eun, H. S. Cho, and C. W. Lee, Korea Advanced Institute of Science and Technology, Seoul, KOREA

4:30-5:00
Simulation and Discrete Time Modeling of Machine Tool Feed Drive Dynamics 474
P. K. Kulkarni, K. Srinivasan, and W. C. Johnson, Ohio State Univ., Columbus, OH

5:00-5:15
Machine Tool Adaptive Control 482
L. K. Lauderbaugh and A. G. Ulsoy, Univ. of Michigan, Ann Arbor, MI

SESSION WP9: Penguin
STOCHASTIC SYSTEMS

Chair: A. H. Haddad, Georgia Institute of Technology, Atlanta, GA
Co-Chair: A. Haurie, GERAD, Montreal, Quebec, CANADA

2:30-3:00
Distributed Asynchronous Deterministic and Stochastic Gradient Optimization Algorithms 484
J. N. Tsitsiklis, Berkeley, CA; D. P. Bertsekas and M. Athans, LIDS, Massachusetts Institute of Technology, Cambridge, MA

3:00-3:30
Control Effort Considerations in the Stabilization of Uncertain Dynamical Systems 490
I. R. Petersen and B. R. Barmish, Univ. of Rochester, Rochester, NY

3:30-4:00
Minimal Order Estimation of Multivariable Continuous Time Stochastic Linear Systems 496
Y. Baram and U. Shaked, Tel-Aviv Univ., ISRAEL

4:00-4:15
Optimal Control of Jump-Linear Gaussian Systems †
B. E. Griffiths, Reading, MA

4:15-4:30
Stochastic Control with Searching for a Randomly Moving Target 500
A. Ohsumi, Kyoto Institute of Technology, Kyoto, JAPAN

4:30-5:00
Mechanical Pulp Refiner Transfer Function Identification, a Stochastic Approach 505
M. H. Zand, California State Univ., Sacramento, CA; S. M. Wu, Univ. of Wisconsin-Madison, Madison, WI

SESSION WP10: Marlin
PROCESS MODEL-BASED CONTROL AND ANALYSIS

Organizer and Chair: L. D. Durbin, Texas A&M Univ., College Station, TX
Co-Chair: M. N. Karim, Colorado State Univ., Fort Collins, CO

2:30-3:00 (I)
Conditionally Stable Tuning with PI and PID Controllers on Common Processes 512
J. P. Gerry, The Foxboro Co., Foxboro, MA

3:00-3:30 (I)
A Study of Pole Placement in Linear Control Design 518
L. S. Tung, Monsanto Co., St. Louis, MO; T. F. Edgar, Univ. of Texas, Austin, TX

3:30-4:00 (I)
A General Purpose Digital Control Algorithm 524
F. Tu and J. Tsing, Measurex Corp., Cupertino, CA

4:00-4:30 (I)
Control Sensitivity to Process Variation 528
T. Kraus, The Foxboro Co., Foxboro, MA

4:30-5:00 (I)
Stability of the Dahlin Digital Controller in the Presence of Deadtime Variations 536
J. M. Vandeursen and J. A. Peperstraete, Katholieke Univ. of Leuven, Heverlee, BELGIUM

5:00-5:30 (I)
Simulation Study of Adaptive First Order with Deadtime Compensators 543
L. D. Durbin, Texas A&M Univ., College Station, TX

SESSION WP11: Penthouse Suite (at top of highrise Tower)
APPLICATIONS OF MULTIVALUED LOGIC

Organizer and Chair: E. Sanchez, Univ. of Marseille, FRANCE
Co-Chair: E. H. Ruspini, Hewlett Packard Lab., Palo Alto, CA

2:30-3:00 (I)
A Survey of Uncertainty Measures: Structures and Applications 549
H. T. Nguyen, New Mexico State Univ., Las Cruces, NM

3:00-3:30 (I)
Combination of Non Distinct Evidences 554
P. Smets, Brussels Univ., BELGIUM

3:30-4:00 (I)
Klein Groups in Fuzzy Inference 556
I. B. Turksen, Univ. of Toronto, Ontario, CANADA

4:00-4:30 (I)
Measures of Fuzziness and Separating Power in Ecological Sampling Problems 561
C. Dujet, INSA, Villeurbanne, FRANCE

4:30-5:00 (I)
An Approach to Truth Functional Modification †
R. R. Yager, Iona College, New Rochelle, NY

5:00-5:30 (I)
On the Combination of Fuzzy Quantifiers in Natural Languages 566
E. Sanchez, Univ. of Marseille, FRANCE

WEDNESDAY EVENING
June 6, 1984

SESSION WE1: Islands A
MICROPROCESSOR IMPLEMENTATION OF REAL TIME CONTROL SYSTEMS USING HIGH ORDER LANGUAGES

Organizer and Chair: W. Merrill, NASA Lewis Research Center, Cleveland, OH
Co-Chair: P. K. Houpt, Massachusetts Institute of Technology, Cambridge, MA

7:00-7:15 P.M. (I)
A Programming Language for Real-Time Automotive Control Applications 570
E. Nelson, Ford Motor Co., Dearborn, MI

7:15-7:30 P.M. (I)
A Real-Time Fortran Implementation of a Sensor Failure Detection Isolation and Accommodation Algorithm 572
J. DeLaat, NASA Lewis Research Center, Cleveland, OH

7:30-7:45 P.M. (I)
PLM Implementation of a Multiple Closed-Loop Control Strategy for a Microprocessor-Controlled Respirator 574
K. Behbehani, Bennett Medical Equipment, Los Angeles, CA

7:45-8:00 P.M. (I)
The Use of High Order Languages in Microprocessor Based Systems 1903
T. F. Westermeier and H. E. Hansen, McDonnell Douglas Corp., St. Louis, MO

8:00-8:15 P.M. (I)
Pictures to PROM †
A. Klein, Hamilton Standard, Windsor Locks, CT

8:15-8:30 P.M. (I)
Application of a High Order Language to an Automotive Microprocessor †
D. DeWaard, Ford Aerospace and Communications, Newport Beach, CA

8:30-9:00 P.M.
Panel Discussion
Panelists: Session Authors

SESSION WE2: Islands B
CONTROL ENGINEERING FOR ENERGY CONSERVATION, 1974-1994

Co-Organizers: A. Kaya, Univ. of Akron, Akron, OH; L. Rastogi, Measurex Corp., Cupertino, CA
Chair: T. Stout, Profimatics, Thousand Oaks, CA
Co-Chair: L. Rastogi, Measurex Corp., Cupertino, CA

7:00-7:15 P.M. (I)
The Effect of Energy Crisis on Technology: The Role of Control Engineering 577
A. Kaya, Univ. of Akron, Akron, OH

7:15-7:30 P.M. (I)
Sensors and Controls for Steel Industry-A Department of Energy View 1862
J. C. Fulton, U.S. Dept. of Energy, Washington, DC

7:30-7:45 P.M. (I)
Control Engineering and Energy Conservation: An Example Project of how Both Disciplines Can Coexist 579
S. E. Hunt, St. Regis Corp., West Nyack, NY

7:45-8:00 P.M. (I)
Floating Set Points for Conserving Energy in Compressor Systems †
J. Brushwood, EPRI, Palo Alto, CA

8:00-8:15 P.M. (I)
An Experience with Dynamic Simulation of an Industrial Steam System 581
T. Stout, Profimatics, Thousand Oaks, CA

8:15-8:30 P.M. (I)
Energy Conservation Efforts at Inland Steel Company 583
S. P. Arethas, Inland Steel Co., East Chicago, IN

8:30-9:00 P.M.
Panel Discussion
Panelists: Session Authors

THURSDAY MORNING
June 7, 1984

SESSION TA1: Mermaid
MULTITARGET TRACKING

Organizer and Chair: C. Y. Chong, Advanced Information and Decision Systems, Mountain View, CA
Organizer and Co-Chair: Y. Bar-Shalom, Univ. of Connecticut, Storrs, CT

8:30-9:00 (I)
An Approach to the Target Data Association Problem Using Subjective and Statistical Information 587
I. R. Goodman, Naval Oceans Systems Center, San Diego, CA

9:00-9:30 (I)
Localization of Multiple Targets from Doppler Measurements 593
B. Friedlander and J. O. Smith, Systems Control Technology, Inc., Palo Alto, CA

9:30-10:00 (I)
Hierarchical Multitarget Tracking and Classification-A Bayesian Approach 599
C. Y. Chong and S. Mori, Advanced Information and Decision Systems, Mountain View, CA

10:00-10:30 (I)
Track Segment Association with a Distributed Field of Sensors 605
J. Arnold and R. Mucci, Bolt, Beranek and Newman, Inc., Cambridge, MA; Y. Bar-Shalom, Univ. of Connecticut, Storrs, CT

10:30-11:00 (I)
A Tracking Algorithm for Dense Target Environments 613
C. B. Chang, K. P. Dunn, and L. C. Youens, Massachusetts Institute of Technology-Lincoln Lab, Lexington, MA

11:00-11:30 (I)
Adaptive Detection Threshold Optimization for Tracking in Clutter 619
S. Gelfand, Massachusetts Institute of Technology, Cambridge, MA; T. E. Fortmann, Bolt, Beranek and Newman, Inc., Cambridge, MA; Y. Bar-Shalom, Univ. of Connecticut, Storrs, CT

SESSION TA2: Regency B
ROBOT AND MANIPULATOR DYNAMICS

Chair: H. Asada, Massachusetts Institute of Technology, Cambridge, MA
Co-Chair: A. G. Ulsoy, Univ. of Michigan, Ann Arbor, MI

8:30-9:00
A Fast Computational Scheme for Dynamic Control of Manipulators 625
D. T. Horak, Bendix Advanced Technology Center, Columbia, MD

9:00-9:30
Dynamic Simulation of a Flexible Robot Arm and Controller 631
N. G. Chalhoub and A. G. Ulsoy, Univ. of Michigan, Ann Arbor, MI

9:30-10:00
Automatic Dynamics Simplification for Robot Manipulators †
C.-S. Lin and P.-R. Chang, Institute of Information Science, Taipei, Taiwan, Rep. of CHINA

SESSION TA3: Regency C
INDUSTRIAL PROCESS CONTROL

Organizer and Chair: A. al-Shaikh, Measurex Corp., Cupertino, CA
Co-Chair: L. Rastogi, Measurex Corp., Cupertino, CA

8:30-9:00 (I)
Computerized Energy Management in an Integrated Steel Plant 638
R. J. Stark, Armco, Inc., Middletown, OH

9:00-9:30 (I)
The Application of Dynamic Process Models to the On-Line Supervisory Control of the Kamyr Digester 644
Y. L. Sidrak, L. F. Albright, and T. J. Williams, Purdue Univ., West Lafayette, IN

9:30-10:00 (I)
Applications of Real-Time Interactive Graphics 650
C. Wells, Cad Trak Corp., Sunnyvale, CA

10:00-10:30 (I)
New Operational Principles for Multi-Computer Control Environment 656
D. J. Damsker, Damsker Consulting Services, Inc., New York, NY

SESSION TA4: Islands A
PREDICTIVE CONTROL: FURTHER THEORY AND APPLICATIONS TO CHEMICAL PROCESS CONTROL

Organizer and Chair: J. G. Reid, Systems Control Technology, Inc., Daylon, OH
Co-Chair: O. A. Asbjornsen, Univ. of Houston, Houston, TX

8:30-9:00 (I)
Implications of Internal Model Control for PID Controllers 661
M. Morari and S. Skogestad, California Institute of Technology, Pasadena, CA; D. F. Rivera, University of Wisconsin, Madison, WI

9:00-9:30 (I)
Feed Forward Predictive and Adaptive Control by the Dynamic Matrix 1864
O. A. Asbjornsen, Univ. of Houston, Houston, TX; C. R. Culler, Shell Oil Co., Houston, TX

9:30-10:00 (I)
A Linear Programming Approach to Constrained Multivariable Control 667
C. Brosilow, G. Q. Zhao, and K. C. Rao, Case Western Univ., Cleveland, OH

10:00-10:30 (I)
Quadratic Programming Solution of Dynamic Matrix Control (QDMC) †
C. E. Garcia, A. M. Morshedi, and T. J. Fitzpatrick, Shell Development, Houston, TX

10:30-11:00 (I)
IDCOM Hierarchial Control of an Oil Refinery Reactor 675
G. Martin, Set Point, Inc., Houston, TX

11:00-11:30 (I)
Model Algorithmic Control of a Nonlinear Three-Phase Electric Arc Furnace 679
P. B. Usoro and R. K. Mehra, Scientific Systems, Inc., Cambridge, MA

SESSION TA5: Islands B
DESIGN OF MULTIVARIABLE SYSTEMS

Organizer and Chair: C. A. Desoer, Univ. of California, Berkeley, CA
Co-Chair: M. Athans, Massachusetts Institute of Technology, Cambridge, MA

8:30-9:00 (I)
The LQG/LTR Multivariable Control System Design Method †
M. Athans and G. Stein, Massachusetts Institute of Technology, Cambridge, MA

9:00-9:30 (I)
H^{∞} Methods in Optimal Design †
G. Zames, McGill Univ., Montreal, Quebec, CANADA

9:30-10:00 (I)
A Perspective on the Use of Semi-Infinite Optimization in Control System Design 686
E. Polak, Univ. of California, Berkeley, CA

10:00-10:30 (I)
Design of Nonlinear Multivariable Feedback Controls by Total Synthesis 688
J. L. Peczkowski, Bendix Energy Center, South Bend IN; M. K. Sain, Notre Dame Univ., Notre Dame IN

10:30-11:00 (I)
A Feedback Theory of Two-Degree-Of-Freedom Optimal Wiener-Hopf Design 698
J. J. Bongiorno, Jr. and D. C. Youla, Polytechnic Institute of New York, Farmingdale, NY

11:00-11:30
Panel Discussion:
Panelists: C. A. Desoer, Chair, the authors plus E. Bristol, Foxboro Co., Foxboro, MA; C. L. Gustafson, Aerospace Corp., Los Angeles, CA

SESSION TA6: Dolphin
CONTROL EXPERIMENT FOR FLEXIBLE STRUCTURES

Organizer and Chair: J. N. Juang, NASA-LaRC, Hampton, VA
Co-Chair: R. N. Longman, Columbia Univ., New York, NY

8:30-9:00 (I)
Identification of the Dynamics of a Two-Dimensional Grid Structure Using Least Square Lattice Filters 704
R. C. Montgomery and N. Sundarajan, NASA-LaRC Hampton, VA

9:00-9:30 (I)
Exact Nonlinear Command Generation and Tracking for Robot Manipulators and Spacecraft Slewing Maneuvers 710
T. A. W. Dwyer and G. K. F. Lee, Colorado State Univ., Fort Collins, CO

9:30-10:00 (I)
Structural Concepts for Precision Control in Large Flexible Space Systems †
H. Harcrow, G. Morosow, Martin Marietta Aerospace, Denver, CO; L. Rogers, AFWAL, Wright-Patterson, OH

10:00-10:30 (I)
An Experiment to Demonstrate Active and Passive Control of a Flexible Structure †
C. S. Major and R. Gluck, TRW Space and Technology, Redondo Beach, CA

10:30-11:00 (I)
Demonstration and Validation of Closed-Loop Structural Dynamics and Control †
J. R. Sesak, General Dynamics, San Diego, CA

11:00-11:30
Panel Discussion: Future Space Structure and Control Experiments
Moderator: L. D. Pinson, NASA-LaRC, Hampton, VA

SESSION TA7: Sandpiper
MISSILE GUIDANCE AND CONTROL SYSTEMS

Organizer and Chair: C. F. Lin, Boeing Military Airplane Co., Seattle, WA
Organizer and Co-Chair: W. H. Gilbert, Martin Marietta Corp., Orlando, FL

8:30-9:00 (I)
How Autopoint Requirements Constrain the Aerodynamic Design of Homing Missiles 716
F. W. Nesline and M. L. Nesline, Raytheon Co., Bedford, MA

9:00-9:30 (I)
Requirements for the Map in a Map-Matching Guidance System 731
D. D. Pasik, Martin Marietta Aerospace, Orlando, FL; D. A. Hawkins, Defense Mapping Agency, Washington, DC; J. A. McLean, U.S. Army Missile Command, Redstone Arsenal, AL; J. R. McMasters, Goodyear Aerospace Corp., Akron, OH

9:30-10:00 (I)
Optimal Controller for Homing Missile 737
W. R. Yueh, Northrop Electronics Div., Hawthorne, CA; C.-F. Lin, Boeing Military Airplane Co., Seattle, WA

10:00-10:30 (I)
Correlation of Linear and Nonlinear Radome Error Induced Miss Distance Predictions 743
T. Murray, Raytheon Co., Bedford, MA

10:30-11:30
Panel Discussion: New Missile Guidance and Control Technology 751
Panelists: Organizers and Authors

SESSION TA8: Seagull
AUTOMATION IN INTEGRATED CIRCUIT MANUFACTURING

Organizer and Chair: R. W. Atherton, Fairchild Research Center, Palo Alto, CA
Co-Chair: N. Chowla, Fairchild Research Center, Palo Alto, CA

8:30-9:00 (I)
The Application of Control Theory to the Automation of I.C. Manufacturing: Progress and Problems 752
R. W. Atherton, Fairchild Research Center, Palo Alto, CA

9:00-9:30 (I)
Automation of Electronics Testing and Data Analysis for Process Control 757
M. Murphy-Hoye, Fairchild Research Center, Palo Alto, CA

9:30-10:00 (I)
Process and Product Testing in VLSIC Manufacturing †
P. A. Crossley, Fairchild Research Center, Palo Alto, CA

10:00-10:30 (I)
Computer Aided Control of the Integrated Circuit Manufacturing Process 763
U. Kaempf, Hewlett-Packard Labs, Palo Alto, CA

10:30-11:00 (I)
Characterizing and Controlling Integrated Circuit Manufacturing Equipment †
C. L. Mallory, Prometrix, Sunnyvale, CA

11:00-11:30
Panel Discussion:
Panelists: Session Authors

SESSION TA9: Penguin
DECOMPOSITION AND DECENTRALIZATION TECHNIQUES

Chair: S. H. Javid, General Electric Co., Schenectady, NY
Co-Chair: A. Saberi, Washington State Univ., Pullman, WA

8:30-9:00
Quasi-Kalman Decomposition and Its Relation to State Feedback 772
D. L. Boley and W.-S. Lu, Univ. of Minnesota, Minneapolis, MN

9:00-9:30
State Space Decomposition into Cyclic Subspaces and Transformation to the Jordan Form 776
R. P. Guidorzi, Univ. of Bologna, Bologna, ITALY; T. E. Bullock and G. Basile, Univ. of Florida, Gainesville, FL

9:30-10:00
Pseudo-Decoupling and Control of Unidentified Plant 781
S. Thompson, Queen's Univ. of Belfast, Belfast, N. IRELAND

10:00-10:30
Decentralized Control Via the Block Sequential Return Difference Method 787
A. W. K. Leung and W. S. Levine, Univ. of Maryland, College Park, MD

10:30-10:45
Robust Decentralized Control for Nonlinear Interconnected Systems Using Optimal Control 793
A. Saberi, Washington State Univ., Pullman, WA

10:45-11:00
Decentralized Decoupled State Detection in Linear Systems 796
S. Engell and D. Konik, Univ. Gesamthochschule-Duisburg, Duisburg, Federal Republic of GERMANY

11:00-11:30
Active Control Performance Enhancement for Reduced Order Models of Large Scale Systems: Part I-Model Reduction and Enhancement 1905
O. Ibidapo-Obe, Univ. of Lagos, NIGERIA

SESSION TA10: Marlin
CONTROLLER DESIGN FOR NONLINEAR SYSTEMS

Organizer and Chair: J. H. Taylor, General Electric Co., Research and Development, Schenectady, NY
Co-Chair: J. K. Hedrick, Massachusetts Institute of Technology, Cambridge, MA

8:30-9:00 (I)
Application of NQG Control with Uncertain and Incomplete Measurements 798
J. B. Beamon, Univ. of Texas, Austin, TX

9:00-9:30 (I)
Limit Cycle Computation and Stability for Multivariable Nonlinear Systems 803
A. A. Ambrosigbe and J. K. Hedrick, Massachusetts Institute of Technology, Cambridge, MA

9:30-10:00 (I)
A Nonlinear Systems Approach to Control Systems Design †
G. Meyer, NASA Ames, Moffett Field, CA

10:00-10:30 (I)
Nonlinear Feedback Control of D.C. Stepping Motors †
M. J. Balas, Rensselaer Polytechnic Institute, Troy, NY; E. Hammon, Superior Electric Co., Bristol, CT

10:30-11:00 (I)
Multiple Solutions for Continuous Nonlinear Systems (A Catastrophe) 808
A. J. Fish, Univ. of Hartford, West Hartford, CT

11:00-11:30 (I)
Applications of a Nonlinear Controller Design Approach Based on Quasilinear System Models 817
J. H. Taylor and K. L. Strobel, General Electric Co., Research and Development, Schenectady, NY

SESSION TA11: Regency A
POWER SYSTEMS

Chair: A. Kaya, Univ. of Akron, Akron, OH
Co-Chair: T. Stout, Profimatics, Thousand Oaks, CA

8:30-9:00
Stability Criteria for Nonlinear Differential-Integral Systems Arising from Nuclear Reactor Dynamics 825
M. Podowski, Rensselaer Polytechnic Institute, Troy, NY

9:00-9:30
Automated Rule-Base Control for Nuclear Power Plants 840
R. W. Colley, Westinghouse Hanford Co., Richland, WA

9:30-10:00
A Discrete Model Approach to Power System Transient Performance Simulation 846
A. Ramirez-Molina, Officina de Operacion de Sistemas Interconectados, Caracas, VENEZUELA; H. Rudnick, Universidad Catolica de Chile, Santiago, CHILE; F. M. Hughes and A. Bramellar, University of Manchester, Manchester, UK

THURSDAY NOON
June 7, 1984

LUNCHEON
12:00 Regency Room

Luncheon Address: A Hard Look at Software
Allen R. Stubberud, Chief Scientist at the Air Force

SESSION TP1: Mermaid Lounge
DIGITAL SYSTEMS

Chair: P. Belanger, McGill Univ., Montreal, Quebec, CANADA

2:30-3:00
Implementation of Digital Controllers Using Fixed Point Arithmetic; Some Stability Considerations 85
M. E. Ahmed, Worcester Polytechnic Institute, Worcester, MA; P. R. Belanger, McGill Univ., Montreal, Quebec, CANADA

3:00-3:30
The 2.D Faddeva Algorithm Revised 859
K. Benmahammed, Louisiana State Univ., Baton Rouge, LA

3:30-4:00
On the Input-Output Modeling of Nonperiodic Sampling Systems 862
M. de la Sen, Univ. del Pais Vasco, Leioa, SPAIN

SESSION TP2: Regency B
KINEMATICS, DYNAMICS AND CONTROLLER DESIGN FOR ROBOTIC SYSTEMS

Organizer and Chair: J. Y. S. Luh, Clemson Univ., Clemson, SC
Co-Chair: M. W. Walker, Clemson Univ., Clemson, SC

2:30-3:00 (I)
The Kinematics of Open Loop Manipulators Using IMP (Integrated Mechanisms Program) 1870
R. H. Vandervaart, Timken Co., Canton, OH; R. J. Cipra, Purdue Univ., West Lafayette, IN

3:00-3:30 (I)
Dynamic Cartesian Coordinate Control of a Manipulator 866
M. W. Walker, Clemson Univ., Clemson, SC

3:30-4:00 (I)
Dynamic Control Models of a Robot for High Speed and High Precision Assembly with Tolerance Constraints 872
S. S. Wang and A. Sharma, IBM Thomas J. Watson Research Center, Yorktown Heights, NY

4:00-4:15 (I)
On the Implementation of Manipulator Control 878
N. K. Loh, S. K. Cheng, K. C. Cheok, and K. S. Oo, Oakland Univ., Rochester, MI

4:15-4:30 (I)
A Computer Control Structure for Coordination of Two Robot Arms 880
C. O. Alford, Georgia Institute of Technology, Atlanta, GA; S. M. Belyeu, IBM Corp., Boca Raton, FL

4:30-5:00 (I)
Vision-Based Real-Time Robot Control for Capturing Moving Objects †
R. T. Cunningham and T. Brooks, Jet Propulsion Laboratory, Pasadena, CA

5:00-5:30 (I)
Characterization and Control of Object Acquisition with a Sensored Robot Hand 882
J. K. Parker and F. W. Paul, Clemson Univ., Clemson, SC

SESSION TP3: Regency C
ADAPTIVE CONTROL AND APPLICATIONS-II

Organizer and Chair: D. E. Seborg, Univ. of California, Santa Barbara, CA
Co-Chair: G. Dumont, Pulp and Paper Research Institute of Canada, Vancouver, CANADA

2:30-3:00 (I)
Pole Placement Adaptive Control of Processes Described by Discrete Convolution Models †
P. Pavlechko and T. F. Edgar, Univ. of Texas, Austin, TX

3:00-3:30 (I)
Life with Pattern Adaptation 888
E. H. Bristol and T. Kraus, Foxboro Co., Foxboro, MA

3:30-4:00 (I)
Adaptive Control of Polymerization Reactors †
V. M. Gonzales and K. F. Jensen, Univ. of Minnesota, Minneapolis, MN

4:00-4:30 (I)
Experimental Investigation of Adaptive Control of a Distillation Column 893
D. R. Yang and W.-K. Lee, Ohio State Univ., Columbus, OH

4:30-5:00 (I)
Multivariable Self-Tuning Controllers Applicable to Systems with Measurements of Differing Time Delays 899
C. A. Tsiligiannis and S. A. Svoronos, Univ. of Florida, Gainesville, FL

5:00-5:30 (I)
A Self-Tuning Controller for Systems with Unknown or Varying Time Delays 905
I. L. Chien, D. E. Seborg, and D. A. Mellichamp, Univ. of California, Santa Barbara, CA

SESSION TP4: Islands A
ADVANCED CONTROL THEORY AND APPLICATION

Organizer and Chair: T. J. McAvoy, Univ. of Maryland, College Park, MD
Co-Chair: D. E. Haskins, Honeywell PMSD, Phoenix, AZ

2:30-3:00 (I)
The Effect of Interaction on Tuning and Operability of Classically Controlled Systems 913
M. A. Mariño-Galarraga and T. McAvoy, Univ. of Maryland, College Park, MD; T. E. Marlin, Exxon Research and Engineering, Clinton, NJ

3:00-3:30 (I)
Robust Controller Tuning 919
A. Palazoglu and Y. Arkun, Rensselaer Polytechnic Institute, Troy, NY

3:30-4:00 (I)
Singular Value Decomposition Controller Design Using a Reduced Order Model 925
J. G. Gerstle, C. F. Moore, and D. D. Bruns, Univ. of Tennessee, Knoxville, TN; J. M. Keeton, Science Applications, Inc., Oak Ridge, TN

4:00-4:30 (I)
Advanced Control Techniques Applied to a Fossil Power Plant 931
J. M. Keeton, Science Applications, Inc., Oak Ridge, TN

4:30-5:00 (I)
Further Application of Output Predictive Algorithmic Control to Terrain Following 937
M. E. Bise, Wright-Patterson AFB, OH; J. G. Reid, Systems Control Technology, Inc., Dayton, OH

5:00-5:30 (I)
Nonlinear Reduced-Order Models for Staged Processes with Discrete Legendre Orthogonal Polynomials 943
G. Baron, Vrije Universiteit, Brussels, BELGIUM

SESSION TP5: Islands B
ROBUST CONTROL DESIGN

Chair: P. Antsaklis, Univ. of Notre Dame, Notre Dame, IN
Co-Chair: B. R. Barmish, Univ. of Rochester, Rochester, NY

2:30-3:00
Modal Insensitivity with Optimality 949
A. J. Calise and K. V. Raman, Drexel Univ., Philadelphia, PA

3:00-3:30
Stability Robustness Measures Utilizing Structural Information 954
H.-H. Yeh, S. S. Banda, and D. B. Ridgely, Wright Patterson AFB, OH

3:30-4:00
Robustness of Luenberger Observers: Linear Systems Stabilized Via Nonlinear Control 968
A. R. Galimidi and B. R. Barmish, Univ. of Rochester, Rochester, NY

4:00-4:30
Time Domain Robustness Analysis for Linear Regulators 975
R. K. Yedavalli, Stevens Institute of Technology, Hoboken, NJ

4:30-4:45
On the Design of Robust LQ Regulators 981
S. M. Joshi, NASA Langley Research Center, Hampton, VA

4:45-5:00
Estimation of Regions of Attraction and Ultimate Boundedness for Multiloop LQ Regulators 985
S. M. Joshi, NASA-Langley, Hampton, VA

5:00-5:15
Limitations on Feedback Properties Imposed by Unstable Open Loop Poles 990
J. S. Freudenberg, Univ. of Illinois, Urbana, IL; D. P. Looze, Alphatech, Burlington, MA

5:15-5:30
Min-Max Control Laws for Time Delay Systems †
A. M. Basher, South Carolina State College, Orangeburg, SC; D. A. O'Connor, Massachusetts Institute of Technology, Lexington, MA

SESSION TP6: Dolphin
MODELING AND DESIGN BY EXPERIMENTAL MODAL ANALYSIS

Organizer and Chair: C. W. deSilva, Carnegie-Mellon Univ., Pittsburgh, PA
Co-Chair: A. L. Hale, Univ. of Illinois, Urbana, IL

2:30-3:00 (I)
Techniques and Applications of Experimental Modal Analysis in Modeling and Control 992
C. W. deSilva, Carnegie-Mellon Univ., Pittsburgh, PA

3:00-3:30 (I)
Study of a Local Eigenvalue Modification Procedure Using a Generalized Beam Element 998
J. C. O'Callahan and C. M. Chou, Univ. of Lowell, Lowell, MA; P. Avitabile, ECSC, Burlington, MA

3:30-4:00 (I)
Electrotopographic Modal Analysis for Modeling Adaptive Control Systems 1006
M. Ensanian, Ensanian Physico Chemical Institute, Eldred, PA

4:00-4:30 (I)
Eigenvector Modification Through Design Changes 1013
J. M. Starkey, Purdue Univ., West Lafayette, IN

4:30-5:00 (I)
A New Approach to Control System Analysis Using Experimental Data 1019
M. H. Richardson, D. L. Formenti, and D. W. Kientzy, Structural Measurement Systems, San Jose, CA

5:00-5:30 (I)
Recursive Substructuring Algorithms in Dynamics †
A. L. Hale, Univ. of Illinois, Urbana, IL

SESSION TP7: Sandpiper
FLUIDIC SENSORS, CONTROL AND INTERFACE COMPONENTS

Organizer and Chair: C. K. Taft, Univ. of New Hampshire, Durham, NH
Organizer and Co-Chair: E. V. Fudim, Johnson Controls, Milwaukee, WI

2:30-3:00 (I)
An Analysis of Squeeze Film Damping in a Piezoelectric Bender Electro Fluid Converter 1026
T. Burke and C. K. Taft, Univ. of New Hampshire, Durham, NH

3:00-3:30 (I)
The Design of Drift-Free, Fabrication-Fault-Tolerant Fluidic Sensors by Closed Loop Error Suppression 1032
R. M. Phillippi, Accumetrix Corp., Arlington, VA; T. M. Drzewiecki, Science and Technology Associates, Inc., Arlington, VA

3:30-4:00 (I)
A Novel Opto-Fluidic Interface 1038
B. Hockaday, W. Glomb, K. Taylor, and J. Waters, United Technologies Research Center, East Hartford, CT

4:00-4:30 (I)
Wear Measurement and Chip Detection of a Moving Shear Blade Using Fluid Proximity Sensors 1041
G. V. Smith, Univ. of Tennessee, Knoxville, TN

4:30-5:00 (I)
Printed Integrated Circuit Micropneumatics †
E. V. Fudim, Johnson Controls, Inc., Milwaukee, WI

5:00-5:30 (I)
The Open and Blocked Distributed Air Transmission Lines by the Fast Fourier Transform Method 1047
S. H. L. Tsang, M. W. Benson, and R. H. Granberg, Lakeland Univ., Thunder Bay, Ontario, CANADA

SESSION TP8: Seagull
CONTROL SYSTEMS FOR MANUFACTURING

Organizer and Chair: J. H. Rillings, GM Research Labs, Warren, MI
Organizer and Co-Chair: M.-F. Chang, GM Research Labs, Warren, MI

2:30-3:00 (I)
Perturbation Analysis of Discrete Event Dynamical Systems with Applications to Manufacturing 1054
Y. C. Ho and X. R. Cao, Harvard Univ., Cambridge, MA

3:00-3:30 (I)
Control Principles in Flexible Manufacturing 1056
C. K. Whitney, C. S. Draper Laboratory, Cambridge, MA

3:30-4:00 (I)
Design of Hierarchical Control Systems for Automated Job Shops 1062
T. L. Johnson, Bolt Beranek and Newman, Inc., Cambridge, MA

4:00-4:30 (I)
A Syntactic Approach for Structure of Sensor-Based Manufacturing Control Systems †
M. H. Kuo and K. L. Sonin, General Electric Co., Schenectady, NY

4:30-5:00 (I)
Modeling Robot Contour Processes 1065
D. E. Whitney and A. Edsall, C. S. Draper Laboratory, Cambridge, MA

5:00-5:30 (I)
Control of Full Penetration Weld Backbead Width †
D. E. Hardt, P. Filipski, E. Papadopoulous, and G. Fleisig, Massachusetts Institute of Technology, Cambridge, MA

SESSION TP9: Penguin
IDENTIFICATION AND ESTIMATION

Chair: P. Bertrand, Lab. des Signaux et Systemes–CNRS, Gif sur Yvette, FRANCE
Co-Chair: J. L. Speyer, Univ. of Texas, Austin, TX

2:30-3:00
Validation of State Space Models in Non-Gaussian Systems 1072
J. C. Spall, Johns Hopkins Univ., Laurel, MD

3:00-3:30
The Modified Gain Extended Kalman Filter and Parameter Identification in Linear Systems 1077
T. L. Song and J. L. Speyer, Univ. of Texas, Austin, TX

3:30-3:45
Efficient Maximum Likelihood Identification of a Positive Semi-Definite Covariance of Initial Population Statistics 1085
D. R. Haley and J. P. Garner, Business and Technological Systems, Seabrook, MD; W. S. Levine, Univ. of Maryland, College Park, MD

3:45-4:00
Track Detection and Estimation–A Finite State Model †
H. Gish, Bolt Beranek and Newman, Cambridge, MA

4:00-4:15
Parallel Partitioning Estimation 1090
D. Andrisani, II and C.-F. Gau, Purdue Univ., W. Lafayette, IN

4:15-4:30
Robust Fault Detection: The Effect of Model Error 1094
R. L. Kosut and R. A. Walker, Integrated Systems, Palo Alto, CA

4:30-5:00
Dead Time Compensation Via the Time Domain Predictor Method 1097
W. H. Kwon and H. D. Kim, Seoul National Univ., Seoul, KOREA

5:00-5:15
Generalized Linear-Least-Squares Recursive Estimators for Systems with Uncertain Observations 1103
S. A. Mostafa, M. T. El-Hadidi, and A. Y. Bilal, Cairo Univ., Giza, EGYPT

5:15-5:30
An Exact Recursive 2 SLS Version of the Instrumental Variable Estimator-Stability Analysis 1105
P. De Larminat, Lab. de Robotique et d'Informatique Industrielle, Nantes, FRANCE

SESSION TP10: Marlin Club
FAULT-TOLERANT COMPUTERS IN AUTOMATION AND PROCESS CONTROL

Organizer and Chair: A. Ray, C. S. Draper Laboratory, Cambridge, MA
Co-Chair: J. J. Deyst, Jr., C. S. Draper Laboratory, Cambridge, MA

2:30-3:00 (I)
On-Line Repair of a Fault Tolerant Computer 1107
J. H. Wensley, August Systems, Tigard, OR

3:00-3:30 (I)
Validation of Fault Free-Behavior of a Reliable Multiprocessor System 1112
E. Clune, Z. Segall, and D. Siewiorek, Carnegie-Mellon Univ., Pittsburgh, PA

3:30-4:00 (I)
Fault Tolerant Computing in Real-Time Control 1121
S. C. Schwarm and E. P. Shaughnessy, Foxboro Co., Foxboro, MA

4:00-4:30 (I)
Computing in the Presence of Soft Bit Errors 1125
R. Rassmussen, Jet Propulsion Laboratory, Pasadena, CA

4:30-5:00 (I)
Dataflow Models for Fault-Tolerant Control Systems 1131
G. M. Papadopoulos and Arvind, Massachusetts Institute of Technology, Cambridge, MA

5:00-5:30 (I)
A Fault and Damage Tolerant Network for an Advanced Tactical Aircraft 1138
J. H. Lala, A. Ray, and R. Harper, The C. S. Draper Laboratory, Cambridge, MA; D. Mulcare, Lockheed-Georgia, Marietta, GA

SESSION TP11: Regency A
POWER SYSTEM CONTROL

Organizer and Chair: O. I. Elgerd, Univ. of Florida, Gainesville, FL
Co-Chair: R. Bushner, San Diego Gas & Electric Co., San Diego, CA

2:30-3:00 (I)
A Large System Approach Toward Operating the Electric Power System by Decision and Control 1143
J. Zaborszky, Washington Univ., Saint Louis, MO

3:00-3:30 (I)
On the Decentralized Control of Large-Scale Power Systems 1156
M. Jamshidi, Univ. of New Mexico, Albuquerque, NM; M. Etezadi, Univ. of Nevada-Reno, Reno, NV

3:30-4:00 (I)
Analysis of Small Disturbance Stability Regions of Power System Models with Real and Reactive Power Flows 1162
C.-C. Liu, Univ. of Washington, Seattle, WA; F. F. Wu, Univ. of California, Berkeley, CA

4:00-4:30 (I)
Improving Distribution System Performance Through Static Compensation 1166
R. A. Westphal, O. I. Elgerd, and R. L. Sullivan, Univ. of Florida, Gainesville, FL

4:30-5:00 (I)
Modeling Unbalanced Power Systems for Supervisory Monitoring and Control 1171
L. L. Grigsby, Virginia Polytechnic Inst., Blacksburg, VA; D. L. Allen, Consolidated Edison Co., New York, NY; M. A. Wortman, Clemson Univ., Clemson, SC

5:00-5:30
Panel Discussion
Panelists: Session Authors

FRIDAY MORNING
June 8, 1984

PLENARY SESSION II
8:30-9:30 — **Regency Room**

Chair: Herbert E. Rauch, Lockheed Palo Alto Research Lab
Co-Chair: Leonard Shaw, Polytechnic Institute of New York

Keynote Address: New Concepts in Control Theory, 1959-1984
Arthur E. Bryson, Jr.
Pigott Professor of Engineering
Stanford University

SESSION FA1: Mermaid Lounge
CONTROLS IN AUTOMOTIVE SYSTEMS

Organizer and Chair: T. R. Weber, GM Research Laboratories, Warren, MI
Co-Chair: M. Rabins, Wayne State Univ., Detroit, MI

9:45-10:15 (I)
On the Control of Vehicles with Multiple Power Sources — †
S. M. Rohde and T. R. Weber, GM Research Laboratories, Warren, MI

10:15-10:45 (I)
Engine-Air Control (EAC) Fuel Injection System — 1179
T. Ishida, Mikuni Kogyo, Tokyo, JAPAN; D. M. Auslander and M. Tomizuka, Univ. of California-Berkeley, Berkeley, CA; P. Sagues, Berkeley Process Control, Inc., Berkeley, CA; R. L. Woods, Univ. of Texas at Arlington, Arlington, TX

10:45-11:15 (I)
The Problem of Optimal Transmission Control-An Application to an Electric Road Vehicle — 1185
M. Pachter, CSIR, Pretoria, SOUTH AFRICA

11:15-11:45 (I)
Development of a Control System for an Electronic Air Suspension (EAC) System — 1190
E. H. Marquardt and R. J. Sandel, Ford Motor Co., Dearborn, MI

11:45-12:15 (I)
Active Vibration Isolation of Truck Cabs — 1199
A. A. Alexandridis and T. R. Weber, GM Research Laboratories, Warren, MI

12:15-12:45 (I)
Panel Discussion: Future Opportunities for Controls in the Automotive Industry

SESSION FA2: Regency B
ROBOT AND MANIPULATOR CONTROL

Chair: K. G. Shin, Univ. of Michigan, Ann Arbor, MI
Co-Chair: A. K. Bejczy, California Institute of Technology, Pasadena, CA

9:45-10:15
Control of Lightweight Flexible Manipulators: A Feasibility Study — 1209
P. B. Usoro and R. Nadira, Scientific Systems, Cambridge, MA; S. S. Mahil, Purdue Univ., Hammond, IN

10:15-10:45
On the Closed-Loop Control of an Elastic Industrial Robot — 1217
H.-B. Kuntze and A. Jacubasch, Fraunhofer Institute, Karlsruhe, F. R. GERMANY

10:45-11:15
Analysis and Design of a Direct-Drive Arm with a Five-Bar-Link Parallel Drive Mechanism — 1224
H. Asada and K. Youcef-Toumi, Massachusetts Institute of Technology, Cambridge, MA

11:15-11:45
Open-Loop Minimum-Time Control of Mechanical Manipulators and Its Application — 1231
K. G. Shin and N. D. McKay, Univ. of Michigan, Ann Arbor, MI

11:45-12:15
Modelling and Adaptive Control of a Mechanical Manipulator — 1237
R. P. Anex, Jr. and M. Hubbard, Univ. of California, Davis, CA

12:15-12:30
Robot Arm Control Design: A High Gain Feedback Perspective — 1243
K. D. Young, Systems Control Technology, Palo Alto, CA

SESSION FA3: Regency C
ADAPTIVE CONTROL THEORY

Chair: P. Ioannou, Univ. of Southern California, Los Angeles, CA
Co-Chair: G. S. Axelby, Westinghouse Electric, Baltimore, MD

9:45-10:15
Strong Convergence of RML Algorithms with Truncations for Adaptive Identification and Control of Stable and Unstable Plants — 1246
R. Kumar, Cal State Univ., Long Beach, CA

10:15-10:45
On Model Reference Adaptive Control and Identification — 1252
P. J. Kennedy, Jr., American Bell, Lincroft, NJ

10:45-11:15
Low-Order Model Reference Direct Multivariable Adaptive Control — 1259
I. Bar-Kana and H. Kaufman, Rensselaer Polytechnic Institute, Troy, NY

11:15-11:45
Adaptive Control by Ladder Forms — 1265
S. Olcer and M. Morf, Yale Univ., New Haven, CT

11:45-12:15
A Fine Estimator Structure for Self-Tuning Controller — 1271
K. P. Lam, National Research Council Canada, Ottawa, CANADA

SESSION FA4: Islands A
ROBUSTNESS ISSUES IN PROCESS CONTROL

Organizer: T. J. McAvoy, Univ. of Maryland, College Park, MD
Chair: Y. Arkun, Rensselaer Polytechnic Institute, Troy, NY
Co-Chair: J. Kantor, Univ. of Notre Dame, Notre Dame, IN

9:45-10:15 (I)
Robust Controller Design. A Hybrid Approach — 1277
B. Manousiouthakis and Y. Arkun, Rensselaer Polytechnic Institute, Troy, NY

10:15-10:45 (I)
Control System Design for Multivariable Uncertain Processes — 1283
S. C. Chen and C. B. Brosilow, Case Western Reserve, Cleveland, OH

10:45-11:15 (I)
Integral Controllability, Failure Tolerance, Robustness and the Relative Gain Array — 1290
P. Grosdidier, M. Morari, and B. Holt, California Institute of Technology, Pasadena, CA

11:15-11:45 (I)
Sensitivity Analysis for Model Based Control Configurations — 1296
P. J. Antsaklis and J. C. Kantor, Univ. of Notre Dame, Notre Dame, IN

11:45-12:15 (I)
Single and Multi-variable Control with Extended Prediction Horizons — 1303
B. E. Ydstie and L. K. Liu, Univ. of Massachusetts, Amherst, MA

12:15-12:45 (I)
A Method for Improving the Stability Characteristics of Self-Tuning Control — 1309
A. Papadoulis and S. A. Svoronos, Univ. of Florida, Gainesville, FL

SESSION FA5: Island B
LINEAR SYSTEMS

Chair: P. Dorato, Univ. of New Mexico, Albuquerque, NM
Co-Chair: S. M. Meerkov, Illinois Institute of Technology, Chicago, IL

9:45-10:00
Non-BDF Methods for the Solution of Linear Time Varying Implicit Differential Equations — 1315
S. L. Campbell, North Carolina State Univ., Raleigh, NC

10:00-10:15
Stability of Fast Periodic Systems — 1319
R. Bellman, Univ. of Southern California, Los Angeles, CA; J. Bentsman and S. M. Meerkov, Illinois Institute of Technology, Chicago, IL

10:15-10:30
Four Equivalent Notions of Stabilizability of Periodic Linear Systems — 1321
S. Bittanti and P. Bolzern, Politecnico di Milano, Milano, ITALY

10:30-10:45
Equivalence to Smith Form for Matrices over Rings — 1324
M. C. Smith and Y. S. Hung, Univ. of Cambridge, Cambridge, UNITED KINGDOM

10:45-11:15
An Algorithm for the Design of Multi-Functional Observers — 1326
C.-C. Tsui, Northeastern Univ., Boston, MA

11:15-11:45
Synthesis and Design of Feedback Control Systems for Time Response I — 1332
C. J. Maday, North Carolina State Univ., Raleigh, NC

11:45-12:15
The Convex Controller: Controllability in Finite Time — 1338
M. E. Evans, The Univ. of Western Australia, Nedlands, W. AUSTRALIA

12:15-12:45
Set-Theoretic Analysis of Linear Control Systems with Unknown-But-Bounded Inputs — 1344
P. B. Usoro, Scientific Systems, Cambridge, MA

SESSION FA6: Dolphin
REDUCED ORDER MODELING AND CONTROL

Chair: E. I. Verriest, Georgia Institute of Technology, Atlanta, GA
Co-Chair: J. R. Winkelman, General Electric Co., Schenectady, NY

9:45-10:15
Power Spectrum Reduction by Optimal Hankel Norm Approximation of the Phase of the Outer Spectral Factor 1352
E. A. Jonckheere, Univ. of Southern California, Los Angeles, CA; J. W. Helton, Univ. of California-San Diego, San Diego, CA

10:15-10:30
Controller Reduction by Convariance Equivalent Realizations 1360
A. Yousuff, Drexel Univ., Philadelphia, PA; R. E. Skelton, Purdue Univ., W. Lafayette, IN

10:30-10:45
Basic Results for Multiple-Frequency Scale Systems 1366
D. W. Luse, Virginia Polytechnic Institute and State Univ., Blacksburg, VA

10:45-11:15
An Algebraic Approach to Analysis and Control of Time-Scales 1368
X.-C. Lou, G. C. Verghese, and A. S. Willsky, Massachusetts Institute of Technology, Cambridge, MA; M. Vidyasagar, Univ. of Waterloo, Ontario, CANADA

11:15-11:45
Multi-Area Aggregates Incorporating Field Flux Dynamics 1373
S. Ahmed-Zaid, Univ. of Illinois, Champaign, IL; J. R. Winkelman, General Electric Co., Schenectady, NY

11:45-12:00
Analysis of a Class of Model Reduction Algorithms: Results of a Power Plant System Approximation 1381
L. Fortuna and A. Gallo, Univ. di Catania, Catania, ITALY

12:00-12:15
Low Order Observer for Discrete-Time Systems with Slow and Fast Modes 1384
M. T. Tran, Boeing Military Airplane Co., Wichita, KS; M. E. Sawan, Wichita State Univ., Wichita, KS

12:15-12:45
Multirate and Composite Control of Two-Time-Scale Discrete-Time Systems 1385
B. Litkouhi and H. Khalil, Michigan State Univ., East Lansing, MI

SESSION FA7: Sandpiper
TRACKING AND MISSILE CONTROL

Chair: B. Friedland, The Singer Company, Little Falls, NJ
Co-Chair: R. R. Mohler, Dept. of Navy, Monterey, CA

9:45-10:15
Dynamic Analysis of Shipboard-Mounted Tracking Antennas 1391
J. Choi, Naval Coastal Systems Center, Panama City, FL; J. A. Kasprzak, Harris Corp., Palm Bay, FL

10:15-10:45
On a Simple Adaptive Tracking Filter 1398
Z. Tang and W. J. Kolodziej, Oregon State Univ., Corvallis, OR; R. R. Mohler, Dept. of the Navy, Monterey, CA

10:45-11:00
A New Approach to the Maneuvering Target Tracking Problem 1404
N. O. Speakman, Eglin Air Force Base, FL; T. E. Bullock, Univ. of Florida, Gainesville, FL

11:00-11:15
Bank-to-Turn Control 1406
D. Caughlin, Edwards AFB, CA; T. E. Bullock, Univ. of Florida, Gainesville, FL

11:15-11:45
Near-Optimal Guidance Law for a Bank-to-Turn Missile 1408
R. K. Aggarwal and C. R. Moore, Raytheon Co., Bedford, MA

11:45-12:15
Minimum Time Flight Policy of Guided Missile 1416
I. A. El-Salam, Alexandria Univ., Alexandria, EGYPT; M. A. El-Rahim, Air Defense Coll., Alexandria, EGYPT

12:15-12:45
Flight Policy of Guided Missile with Minimum Normal Acceleration 1422
I. A. El-Salam, Alexandria Univ., Alexandria, EGYPT; A. E. L. El-Asran, Air Defense Coll., Alexandria, EGYPT

SESSION FA8: Seagull
MULTI-AGENT DECISION PROBLEMS

Organizer and Chair: P. B. Luh, Univ. of Connecticut, Storrs, CT
Organizer and Co-Chair: T. S. Chang, State Univ. of New York, Stony Brook, NY

9:45-10:15 (I)
Distributed Production Networks 1427
E. Tse and C. Y. Chong, Advanced Information and Decision Systems, Mountain View, CA

10:15-10:45 (I)
Stackelberg Game Approach to Operation Scheduling Problems 1434
S. C. Chang and P. B. Luh, Univ. of Connecticut, Storrs, CT; T. S. Chang, State Univ. of New York, Stony Brook, NY

10:45-11:00 (I)
A Distributed Aeroacoustic Tracking Algorithm 1440
R. R. Tenney, Massachusetts Institute of Technology, Cambridge, MA; J. R. Delaney, MIT Lincoln Lab, Lexington, MA

11:00-11:15 (I)
Game Theoretic Analysis of Ship Positioning in a Naval Battle Force †
D. A. Castanon, Alphatech Inc., Burlington, MA

11:15-11:45 (I)
Performance Versus Informativeness in LQG Multi-Objective Control Problems 1451
M. Tu and G. P. Papavassilopoulos, Univ. of Southern California, Los Angeles, CA

11:45-12:15 (I)
Adaptive Incentive Controls for Stackelberg Games with Unknown Cost Functionals 1457
T. L. Ting, J. B. Cruz, Jr., and R. A. Milito, Univ. of Illinois, Urbana, IL

12:15-12:45 (I)
Overtaking Equilibria for Infinite Horizon Games †
A. Haurie, Ecole des Hautes Etudes Commerciales, Montreal, Quebec, CANADA; B. Tolwinski, Univ. of Puerto Rico, Rio Piedras, P.R.

SESSION FA9: Penguin
FILTERING AND ESTIMATION

Chair: R. Travassos, Systolic Systems, San Jose, CA
Co-Chair: J. K. Tugnait, Exxon Product Research Co., Houston, TX

9:45-10:15
Constrained Signal Restoration via Iterated Extended Kalman Filtering 1464
J. K. Tugnait, Exxon Product Research Co., Houston, TX

10:15-10:45
The Robust Equation of Nonlinear Filtering 1470
G. S. Ferreyra, Louisiana State Univ., Baton Rouge, LA

10:45-11:15
Event Time Errors in Covariance Matrix Propagation 1475
J. N. Churchyard, Brunswick, Corp., Costa Mesa, CA

11:15-11:45
Adaptive State Variable Estimation Using Robust Smoothing 1481
F. D. Groutage, Naval Ocean System Center; R. G. Jacquot, Univ. of Wyoming, Laramie, WY; D. E. Smith, Computer Sciences Corp.

11:45-12:00
Nonlinear Estimation of Dynamic Shift and Shape Parameters from Set Function Measurements 1484
Y. Bresler and A. Macovski, Stanford Univ., Stanford, CA

12:00-12:15
Optimal and Suboptimal Filtering for Time-Invariant Systems Excited by Compound Poisson Processes 1486
R. M. Rogers, Systems Dynamics, Gainesville, FL

12:15-12:30
Nonlinear Observation via Global Optimization Methods–The Measure Theory Approach 1489
E. A. Galperin, Univ. du Quebec a Montreal, Montreal, Quebec, CANADA; Q. Zheng, Shanghai Univ. of Science and Technology, Shanghai, CHINA and Pennsylvania State Univ., University Park, PA

12:30-12:45
Kalman Filtering with Preprocessed Quantized Measurements 1491
H. M. Faridani, National Univ. of Iran, Tehran, IRAN

SESSION FA10: Marlin Club
NONLINEAR SYSTEMS

Chair: A. N. Michel, Iowa State Univ., Ames, IA
Co-Chair: B. Lurie, TRW Military Electronics Div., Redondo Beach, CA

9:45-10:15
Two-Level Control Laws for Discrete-Time Non-Linear Systems 1493
H. Abou-Kandil, M. Drouin, and P. Bertrand, Laboratoire des Signaux et Systemes, Gif-sur-Yvette, FRANCE

10:15-10:45
Computer Aided Design of Non-Linear Systems 1498
A. D. G. Hazlerigg, Univ. of Sussex, ENGLAND; M. N. Sahinkaya, Univ. of Strathclyde, Glasgow, SCOTLAND

10:45-11:15
Nonlinear Correction for Feedback Maximization, Describing Function Approach 1504
B. J. Lurie, TRW Military Electronics Div., Redondo Beach, CA

11:15-11:30
Input-Output Stability Analysis with Magnetic Hysteresis Non-Linearity–A Class of Multipliers 1508
M. G. Safonov and K. Karimlou, Univ. of Southern California, Los Angeles, CA

11:30-12:00
Nonlinear Singular Systems and Contraction Mappings 1513
S. L. Campbell and J. Rodriguez, North Carolina State Univ., Raleigh, NC

SESSION FA11: Regency A
CONTROL ASPECTS OF ELECTRIC POWER SYSTEMS

Organizer and Chair: L. Atherton, EPRI, Palo Alto, CA
Co-Chair: G. Quentin, EPRI, Palo Alto, CA

9:45-10:15 (I)
Distributed Microprocessor Application to Electric Utility Distribution Protection and Control Systems †
T. J. Kendrew, EPRI, Palo Alto, CA; P. A. Schneiper, General Electric, Malvern, PA

10:15-10:45 (I)
Operating State-of-the-Art Computer Controlled Combined Cycle Power Plant 1520
J. Alvarez-Calderon, Dow Chemicals, Freeport, TX

10:45-11:15 (I)
Advanced Control Aspects of the IGCC Concept 1526
G. E. Terwilliger, A. S. Brower, R. S. Baheti, and R. E. Smith, General Electric, Schenectady, NY; G. H. Quentin, EPRI, Palo Alto, CA

11:15-11:45 (I)
Control and Load-Following Development for Atmospheric Fluidized-Bed Combustion 1534
W. Howe, EPRI, Palo Alto, CA; L. P. Smith and S. Godbole, Babcock & Wilcox, Lynchburg, VA; J. R. Byrd, Tennessee Valley Authority, Chattanooga, TN

11:45-12:15 (I)
Floating Set-Point Compressor Controls †
J. Brushwood, EPRI, Palo Alto, CA

12:15-12:45 (I)
A High Reliability Gas Turbine Control System 1541
A. C. Dolbec, EPRI, Palo Alto, CA

FRIDAY AFTERNOON
June 8, 1984

SESSION FP1: Mermaid
ACTUATORS

Organizer and Chair: E. V. Fudim, Johnson Controls, Inc., Milwaukee, WI
Co-Chair: L. M. Sweet, Princeton Univ., Princeton, NJ

2:30-3:00 (I)
Microprocessor-Based Control of Linear Motors for Magnetic Guidance of Rail Vehicles 1542
B. S. Heck, R. J. Caudill, W. L. Garrard, and L. M. Sweet, Princeton Univ., Princeton, NJ

3:00-3:30 (I)
Optimization of Dynamic Actuator Performance for High-speed Valves 1548
J. P. Karidis and S. R. Turns, Pennsylvania State Univ., University Park, PA

3:30-4:00 (I)
Dual Mode Servo Control System 1556
S. W. Zewari, Virginia Polytechnic Institute and State Univ., Blacksburg, VA

SESSION FP2: Regency B
DYNAMIC CONTROL OF MANIPULATORS

Organizer and Co-Chair: G. Leininger, SOHIO-Research, Cleveland, OH
Chair: J. Y. S. Luh, Clemsen Univ., Clemsen, SC

2:30-3:00 (I)
Implementing Automatic Setup Change via Robots to Achieve Adaptable Assembly 1876
H. Asada and A. Bernard, Massachusetts Institute of Technology, Cambridge, MA

3:00-3:30 (I)
Tool Coordinate Control of a Puma Robot Arm 1560
G. Leininger, SOHIO-Research, Cleveland, OH; P. Backes and C.-H. Chung, Purdue Univ., West Lafayette, IN

3:30-4:00 (I)
Generalized Bilateral Control of Robot Arms 1883
A. K. Bejczy, Jet Propulsion Lab, Pasadena, CA; S. Lee, Univ. of Southern California, Los Angeles, CA

4:00-4:30 (I)
Control Implications of Arm Bracing †
W. Book, Georgia Institute of Technology, Atlanta, GA

4:30-5:00 (I)
An Algorithm for Generating Minimum Distance Collision-Free Paths for Industrial Robots †
J. Y. S. Luh and C. E. Campbell, Purdue Univ., West Lafayette, IN

5:00-5:30 (I)
Adaptive Control of Manipulators Through Repeated Trials 1566
J. Craig, Stanford Univ., Stanford, CA

SESSION FP3: Regency C
ROBUST ADAPTIVE CONTROL

Organizer and Chair: L. Valavani, Massachusetts Institute of Technology, Cambridge, MA
Co-Chair: P. V. Kokotovic, Univ. of Illinois, Urbana, IL

2:30-3:00 (I)
Robust Adaptive Control 1574
P. A. Ioannou, Univ. of Southern California, Los Angeles, CA

3:00-3:30 (I)
Conditioning a Plant for Frequency Selective Adaptive Control with Improved Robustness 1579
C. E. Rohrs and K. Shortelle, Univ. of Notre Dame, Notre Dame, IN

3:30-4:00 (I)
Adaptive Control with Variable Dead-Zone Nonlinearities 1893
D. Orlicki, L. Valavani, M. Athans, and G. Stein, Massachusetts Institute of Technology, Cambridge, MA

4:00-4:30 (I)
Necessary and Sufficient Conditions for Parameter Convergence in Adaptive Control 1584
S. Boyd and S. Sastry, Univ. of California, Berkeley, CA

4:30-5:00 (I)
Instabilities and Stabilization of an Adaptive System 1588
P. Kokotovic and R. Riedle, Univ. of Illinois, Urbana, IL

5:00-5:30 (I)
Monotonically Convergent Parameter Adjustment for Adaptive Control in the Presence of Unstructured Plant Dynamics 1594
J. M. Krause, Honeywell Systems and Research Center, Minneapolis, MN

SESSION FP4: Islands A
CHEMICAL REACTOR CONTROL

Organizer and Chair: K. F. Jensen, Univ. of Minnesota, Minneapolis, MN
Co-Chair: D. A. Mellichamp, Univ. of California, Santa Barbara, CA

2:30-3:00 (I)
Rapid Set Point Attainment of a Reactor Feed Preheat System and Coordination with Reactor Control 1602
A. Lappinga and A. Foss, Univ. of California, Berkeley, Berkeley, CA

3:00-3:30 (I)
Control of a Packed Bed Reactor with Feed-Effluent Exchange 1608
J. Mandler, D. Strand, R. Khanna, and J. Seinfeld, California Institute of Technology, Pasadena, CA

3:30-4:00 (I)
Multivariable Self-Tuning Control of a Tubular Autothermal Reactor 1614
P. E. McDermott, D. A. Mellichamp, and R. G. Rinker, Univ. of California, Santa Barbara, CA

4:00-4:30 (I)
Comparison Sensitivity and Feedback Control for Optimized Chemical Reactors 1621
J. M. Fox, W. J. Schmidt, Jr. and J. C. Kantor, Univ. of Notre Dame, Notre Dame, IN

4:30-5:00 (I)
Application of Adaptive Estimation Theory to Bioreactor Identification †
G. Stephanopoulos and K. Y. San, California Institute of Technology, Pasadena, CA

5:00-5:30
Panel Discussion
Panelists: Session Authors

SESSION FP5: Island B
OPTIMAL CONTROL

Chair: D. R. Haley, B.T.S. Inc., Seabrook, MD
Co-Chair: A. Manitius, Rensselaer Polytechnic Institute, Troy, NY

2:30-3:00
A Control Scheme for a Pole Vaulter Derived from an Optimal-Aiming Strategy 1628
S. Jayasuriya, Michigan State Univ., East Lansing, MI; M. Hubbard, Univ. of California, Davis, CA; D. Hrovat, Ford Motor Co., Dearborn, MI

3:00-3:30
Computer-Aided Design of Control Systems via Parameter Optimization Methods (CADS/POM): An Interactive Graphics Approach 1634
T. Sadeghi, Fairchild Republic Co., Farmingdale, NY; M. Wozny, Rensselaer Polytechnic Inst., Troy, NY

3:30-4:00
Sub-Optimal Bilinear Regulation, with Application to Stability Enhancement of Variable Structure Linear Systems 1641
S. Kimbrough, West Los Angeles, CA

4:00-4:30
Optimal and Suboptimal Measurement Structure Design for Linear Control Systems 1646
D. Ghosh, Bell Labs, Columbus, OH; C. H. Knapp, Univ. of Connecticut, Storrs, CT

4:30-5:00
Closed Form Optimal Control Solutions for Continuous Linear Elastic Systems 1653
S. B. Skaar, Iowa State Univ., Ames, IA

5:00-5:30
Multivariable PID-Controllers Designed by Linear Quadratic State Space Approach 1659
H. Hensel and K. H. Peter, Technical Univ. of Darmstadt, Darmstadt, F.R. GERMANY

SESSION FP6: Dolphin
ROTATIONAL MANEUVERS OF FLEXIBLE SPACECRAFT

Organizer and Chair: J. L. Junkins, Virginia Polytechnic Institute and State Univ., Blacksburg, VA
Co-Chair: J. D. Turner, C. S. Draper Laboratory, Cambridge, MA

2:30-3:00 (I)
Closed-Form Recursive Formula for an Optimal Tracker with Terminal Constraints 1665
J.-N. Juang, NASA Langley Research Center, Hampton, VA; J. D. Turner and H. M. Chun, C. S. Draper Laboratory, Cambridge, MA

3:00-3:30 (I)
Spacecraft Slewing Maneuvers Using a Closed Form Solution for the Neighboring Extremal Path Problem †
H. M. Chun and J. D. Turner, C. S. Draper Laboratory, Cambridge, MA; J.-N. Juang, NASA Langley Research Center, Hampton, VA

3:30-4:00 (I)
Feedback Control of Flexible Spacecraft Large-Angle Maneuvers Using Liapunov Theory 1674
S. R. Vadali, Iowa State Univ., Ames, IA

4:00-4:30 (I)
Exact Spacecraft Detumbling and Reorientation Maneuvers with Vectored Thrusters and Reaction Wheels 1679
T. W. Dwyer, III, Colorado State Univ., Ft. Collins, CO

4:30-5:00 (I)
Reduced-Order Modeling Applied to Optimal Design of Maneuvering Flexible Structures 1685
A. L. Hale and R. J. Lisowski, Univ. of Illinois at Urbana-Champaign, Urbana, IL

5:00-5:30 (I)
Eigenvalue/Eigenvector Optimization Algorithms for Design of Feedback for Flexible Structures †
D. S. Bodden and J. L. Junkins, Virginia Polytechnic Institute and State Univ., Blacksburg, VA

SESSION FP7: Sandpiper
FLUIDIC FLIGHT CONTROL

Organizer and Chair: M. E. Franke, Air Force Institute of Technology, Wright-Patterson AFB, OH
Organizer and Co-Chair: D. R. Keyser, Naval Air Development Center, Warminster, PA

2:30-3:00 (I)
A Fluidic Flight Control System Demonstrator 1691
R. L. Woods, Univ. of Texas at Arlington, Arlington, TX

3:00-3:30 (I)
Performance Evaluation of an Electrofluidic Flight Control Actuator 1695
D. R. Keyser, Naval Air Development Center, Warminster, PA

3:30-4:00 (I)
Fluidics–A Reliable Alternative for Aircraft Control 1701
R. Benoit, Grumman Aerospace Corp., Bethpage, NY

4:00-4:30 (I)
The Design of a Fluidic Low Airspeed Sensor 1708
G. Mon, Harry Diamond Laboratories, Adelphi, MD

4:30-5:00 (I)
Fluidic Rate Sensor Based Navigation System †
S. Tenny and J. Goto, Harry Diamond Laboratories, Adelphi, MD

5:00-5:30 (I)
Dynamic Performance of Fluidic Signal Transmission Systems for Variable Operating Temperatures 1714
S. W. Yip, K.-M. Lee and D. N. Wormley, Massachusetts Institute of Technology, Cambridge, MA

SESSION FP8: Seagull
DISTRIBUTED CONTROL

Organizer and Chair: S. Kallos, Foxboro Co., Foxboro, MA
Co-Chair: E. M. Cohen, Foxboro Co., Foxboro, MA

2:30-3:00 (I)
Project Management of a Distributed Digital Control Project 1720
S. R. Dartt, ARAMCO, Houston, TX

3:00-3:30 (I)
Equipment Shutdown Analysis in a Distributed System 1723
E. M. Cohen, The Foxboro Co., Foxboro, MA

3:30-4:00 (I)
Distributed Approach Applied in the Design of a Simulation Package 1729
H. M. Huynh, Hydro-Quebec, Montreal, CANADA

4:00-4:15 (I)
Developing a Batch Control Strategy Using Batch Formalism and Time Sequence Diagraming 1735
D. Hyland, Fisher Controls, Austin, TX

4:15-4:30 (I)
Man Machine Interface: Guidelines for Evaluation Criteria and Implementation †
J. Scarlet, Honeywell, Inc., Fort Washington, PA

4:30-5:00 (I)
The Human Interface in Process Control Computer Systems 1738
T. A. King, Measurex Corp., Cupertino, CA

4:45-5:00 (I)
The Importance of Communications in Process Control World †
M. O. Greaves, Foxboro Co., Foxboro, MA

SESSION FP9: Penguin
FAULT TOLERANT AEROSPACE SYSTEMS

Organizer and Chair: E. Gai, C. S. Draper Laboratory, Cambridge, MA
Co-Chair: M. B. Adams, C. S. Draper Laboratory, Cambridge, MA

2:30-3:00 (I)
Control System Reconfiguration 1741
W. Vander Velde, Massachusetts Institute of Technology, Cambridge, MA

3:00-3:30 (I)
Investigation of Control Law Reconfigurations to Accommodate a Control Element Failure on a Commercial Airplane 1746
A. J. Ostroff and R. Hueschen, NASA Langley Research Center, Hampton, VA

3:30-4:00 (I)
A Design Methodology for Robust Failure Detection and Isolation 1755
K. R. Pattipati, A. S. Willsky, J. C. Deckert, J. S. Eterno, and J. S. Weiss, Alphatech, Burlington, MA

4:00-4:30 (I)
Effects of Redundancy Management on Reliability Modeling 1763
R. Luppold and E. Gai, C. S. Draper Laboratory, Cambridge, MA; B. K. Walker, MIT, Cambridge, MA

4:30-5:00 (I)
Unified Performance-Reliability Evaluation 1771
J. Meyer, Univ. of Michigan, Ann Arbor, MI

5:00-5:30 (I)
Failure Detection and Isolation by Dynamic Hypothesis Testing 1779
M. B. Adams and H. N. Gross, C. S. Draper Laboratory, Cambridge, MA

SESSION FP10: Marlin Club
CONTROL APPLICATIONS

Chair: K. Baheti, General Electric Co., Schenectady, NY
Co-Chair: M. Nagurka, Carnegie-Mellon Univ., Pittsburgh, PA

2:30-3:00
The Design of a Control System for the Ballast and Trim of an Unmanned Submersible 1786
P. Motyka and E. Bergmann, C. S. Draper Laboratory, Cambridge, MA

3:00-3:30
Kinematic Steering Control of Rail Vehicles 1794
M. L. Nagurka, Carnegie-Mellon Univ., Pittsburgh, PA; J. K. Hedrick, Massachusetts Institute of Technology, Cambridge, MA

3:30-3:45
Determination of Appropriate Cost Functionals for Cam-Follower Design Using Optimal Control Theory 1799
J.-G. Sun, R. W. Longman, and F. Freudenstein, Columbia Univ., New York, NY

3:45-4:00
Speed Control of an Induction Motor Fed by a Current Source Inverter 1801
X. T. Wang, E. Levi, and L. Shaw, Polytechnic Institute of New York, Brooklyn, NY

SESSION FP11: Regency A

CONTROL, OPTIMIZATION, AND PLANNING IN ALTERNATE POWER GENERATION, COGENERATION, AND ENERGY RECOVERY SYSTEMS

Organizer and Chair: D. P. Garg, Duke Univ., Durham, NC

Co-Chair: H. Sehitoglu, Louisiana State Univ., Baton Rouge, LA

2:30-3:00 (I)
A New Coordinated Control Design Method and Its Application to Gasification Plant 1805
A. S. Brower, S. H. Javid, A. S. Patel, and T. D. Younkins, General Electric Co., Schenectady, NY; G. H. Quentin, Electric Power Research Inst., Palo Alto, CA

3:00-3:30 (I)
Computer-Aided Design and Self-Tuning of Digital Control Systems 1811
R. Isermann, Technical Univ. of Darmstadt, WEST GERMANY

3:30-4:00 (I)
Feasibility of Maximum Energy Converting Control of an Ocean Wave Energy Converter 1817
M. Masubuchi and R. Kawatani, Osaka Univ., JAPAN

4:00-4:30 (I)
Control Strategies for Energy Conservation 1823
D. Garg, Duke Univ., Durham, NC

4:30-5:00 (I)
Control and Optimization of Plant Compressors to Save Energy 1829
A. Kaya, The Univ. of Akron, Akron, OH; L. L. Enterline, Bailey Controls Co., Wickliffe, OH

5:00-5:30 (I)
The Design and Implementation of Dual Computer Back-Up System 1899
A. Luo, Research Institute of Electronic Technique Application, Beijing, CHINA

† Manuscript not available for publication.

PARTICIPANT INDEX

Name	Session	Page
Abou-Kandil, H.	FA1O	1493
Adams, M. B.	FP9	CC
	FP9	1779
Aderibigbe, A. A.	TA1O	803
Adler, L.	WP4	†
Aggarwal, R. K.	FA7	14O8
Ahava, O.	WA3	74
Ahmed, M. E.	TP1	853
Ahmed, N.	WA9	CC
	WA9	21O
Ahmed-Zaid, S.	FA6	1373
Ahson, S. I.	WP6	387
Albrighl, L. F.	TA3	644
Alexandridis, A. A.	FA1	1199
Alexandridis, M. G.	WA1	12
Alford, C. O.	TP2	88O
Allen, D. L.	WP11	1171
al-Shaikh, A.	TA3	O-CH
Alvarez-Calderon, J.	FA11	152O
Amin, M.	WP3	339
Anderson, R. O.	WA8	CC
Andrisani, D., II	WP7	CH
	TP9	1O9O
Anex, R. P., Jr.	FA2	1237
Annaswamy, A. M.	WP3	333
	WP3	336
Antsaklis, P. J.	TP5	CH
	FA4	1296
Arapostathis, A.	WA1O	†
Arderna, M. E.	WP7	423
Arethas, S. P.	WE2	583
Arkun, Y.	TP4	919
	FA4	CH
	FA4	1277
Arnold, J.	TA1	6O5
Arvind	TP1O	1131
Asada, H.	TA2	CH
	FA2	1224
	FP2	1876
Asbjornsen, O. A.	TA4	CC
	TA4	1864
Athans, M.	WA5	†
	WP9	484
	TA5	CC
	TA5	†
	FP3	1893
Atherton, R. W.	TA8	O-CH
	TA8	752
	FA11	O-CH
Auslander, D. M.	WP2	28O
	FA1	1179
Avitabile, P.	TP6	998
Axelby, G. S.	FA3	CC
Ayala, I. L.	WP3	†
Backes, P.	FP2	156O
Baheti, K.	FP1O	CH
Baheti, R. S.	FA11	1526
Balas, M. J.	TA1O	†
Banda, S. S.	TP5	954
Banerjee, S.	WA6	16O
Baram, Y.	WP9	496
Bar-Kana, I.	FA3	1259
Barmish, B. R.	WP9	49O
	TP5	CC
	TP5	968
Baron, G.	TP4	943
Bar-Shalom, Y.	TA1	O-CC
	TA1	6O5
	TA1	619
Basher, A. M.	TP5	†
Basile, G.	TA9	776
Beaman, J. B.	TA1O	798
Behbehani, K.	WE1	574
Bejczy, A. K.	FA2	CC
	TP2	1883
Belanger, P. R.	WA1	48
	TP1	CH
	TP1	853
Bellman, R.	FA5	1319
Belyeu, S. M.	TP2	88O
Benmohammed, K.	TP1	859
Benoit, R.	FP7	17O1
Benson, M. W.	TP7	1047
Bentsman, J.	FA5	1319
Bergman, E.	FP1O	1786
Bernard, A.	FP2	1876
Bertrand, P.	TP9	CH
	FA1O	1493
Bertsekas, D. P.	WP9	484
Bialkowski, W. L.	WA3	54
Bilal, A. Y.	TP9	11O3
Bise, M. E.	TP4	937
Biltanti, S.	FA5	1321
Bodden, D. S.	FP6	†
Boley, D. L.	TA9	772
Bolzern, P.	FA5	1321
Bongiorno, J. J., Jr.	TA5	698
Book, W.	FP2	†
Boyd, S.	FP3	1584
Brameller, A.	TA11	846
Bresler, Y.	FA9	1484
Briggs, P.	WA8	†
Bristol, E. H.	TP3	888
Brooks, T.	TP2	†
Brosilow, C.	TA4	667
	FA4	1283
Brower, A. S.	FA11	1526
	FP11	18O5
Brown, D. H.	WA4	99
Bruns, D. D.	TP4	931
Brushwood, J.	WE2	†
	FA11	†
Bryson, A. E., Jr.	Plenary 2	
Bullock, T. E.	TA9	776
	FA7	14O4
	FA7	14O6
Bunn, P. R.	WP3	329
Burke, T.	TP7	1026
Burrows, C. R.	WP5	354
Burrows, J. W.	WA7	191
Bushner, R.	TP11	CC
Byrd, J. R.	FA11	1534
Calise, A. J.	TP5	949
Calfero, M.	WA1	†
Campbell, C. E.	FP2	†
Campbell, S. L.	FA5	1315
	FA1O	1513
Cao, X. R.	TP8	1O54
Carter, H. R.	WA4	85
Cassidy, J. F., Jr.	WP2	CH
Castanon, D. A.	FA8	†
Caudill, R. J.	FP1	1542
Caughlin, D.	FA7	14O6
Chakravarty, A.	WA1	O-CH
	WA7	191
Chalhoub, N. G.	TA2	631
Chandrasekhar, J.	WP8	443
Chang, C. B.	TA1	613
Chang, M-F.	TP5	O-CC
Chang, M. I-J.	WP5	372
Chang, P-R.	TA2	†
Chang, S. C.	TA8	1434
Chang, T. S.	FA8	O-CC
	FA8	1434
Chapel, J. D.	WA7	166
Chen, S. C.	TA4	1283
Cheng, S. K.	TP2	878
Cheok, K. C.	TP2	878
Chien, I. L.	TP3	9O5
Childerson, M. T.	WA4	85
Cho, H. S.	WP8	468
Choi, J.	FA7	1391
Chong, C. Y.	TA1	O-CH
	TA1	599
	FA8	1427
Chou, C. M.	TP6	998
Chowla, N.	TA8	CC
Chun, H. M.	TP6	1O45
	FP6	†
Chung, C-H.	FP2	156O
Churchyard, J. N.	FA9	1425
Cipra, R. J.	TP2	197O
Clune, E.	TP1O	1112
Cohen, E. M.	FP8	CC
	FP8	1723
Colley, R. W.	TA11	84O
Craig, J.	FP2	1566
Crapo, A. W.	WA4	99
Crish, R.	WP3	323
Crossley, P. A.	TA8	†
Cruz, J. B., Jr.	FA8	1457
Cunningham, R. T.	TP2	†
Cutler, C. R.	TA4	1864
Damsker, D. J.	TA3	656
Daniel, K. J.	WA4	99
Dartl, S. R.	FP8	1720
David, R. A.	WA9	222
Deckert, J. C.	WA1	12
	FP9	1755
DeJonge, M. K.	WA7	179
DeLaat, J.	WE1	572
Delaney, J. R.	FA8	1440
DeLarminat, P.	TP9	1105
de la Sen, M.	TP1	862
DePonte, M., Jr.	WP6	409
Desai, M.	WP1	262
Desai, U. V.	WA6	O-CH
	WA6	156
deSilva, C. W.	TP6	O-CH
	TP6	992
Desoer, C. A.	WA10	242
	TA5	O-CH
DeWaard, D.	WE1	†
Deyst, J. J., Jr.	TP10	CC
Dogan, C.	WP8	449
Dolbec, A. C.	FA11	1541
Dorato, P.	FA5	CH
Drouin, M.	FA1O	1493
Drzewiecki, T. M.	WP8	CH
	TP7	1032