INVITATION

On behalf of the American Automatic Control Council (AACC), the Program and Operating Committees invite you to participate in the 1998 American Control Conference (ACC). The AACC, an affiliation of control and systems engineers from eight professional societies, is the United States National Member Organization of IFAC, the International Federation of Automatic Control. IFAC also serves as a cooperating organization for the ACC.

The 1998 ACC will be held in Philadelphia, Pennsylvania on June 24-26 at the Adam's Mark Hotel. The technical program consists of 16 parallel tracks of invited and contributed paper sessions and a 17th track of 5 tutorial sessions. In addition, the 1998 ACC will offer a wide spectrum of valuable and interesting topics in 8 tutorial workshops; 6 are planned prior to the conference and 2 will be held after the conference.

Philadelphia was founded in 1682 by William Penn, an English Quaker. It grew to be the second largest English-speaking city in the world just before the American Revolution. During the Revolution, the First Continental Congress met at Carpenter's Hall in 1774. At the State House, later renamed Independence Hall, patriots declared independence in 1776. In 1787, the Constitutional Convention was held at Independence Hall. Today Philadelphia is the second largest city on the East Coast. Its Downtown, referred to by Philadelphians as Center City, abounds in historical sites and museums. Participants, their families and guests will be able to enjoy the Center City and the surrounding area. The conference will provide a Courtesy Trolley to take participants and their companions to selected Center City locations.

CONFERENCE HIGHLIGHTS

Technical Program Overview

The technical program reflects the rapid growth and strong interest in the field of control systems engineering, which provides a good balance between control theory and a broad spectrum of practical applications. The 1998 ACC has placed an emphasis on Industry and Applications; several special tracks have been created and are identified in the technical program. In addition, the 1998 ACC also has 5 tutorial sessions, each starting off with an hour-long tutorial of the topic and followed by 4 brief state-of-the-art presentations of industry applications, to serve the interests of our industrial participants.

The 1998 ACC technical program is made up of both contributed papers and invited sessions, organized in 16 parallel sessions on Wednesday, Thursday and Friday, and a 17th track of tutorial sessions on Wednesday and Thursday. Each of the 3 conference days begins with a 1-hour plenary lecture, followed by morning, midday and afternoon technical sessions. There are 887 technical papers presented in these sessions, which were selected from a total of 1,183 submitted papers. The program features strong representation in application areas such as manufacturing, automotive, robotics, process control, aerospace, control of structures, power systems, and various industrial control applications; and in the theoretical areas such as robust and adaptive control, nonlinear control, estimation, numerical methods, and intelligent control. The Program-At-A-Glance highlights the tutorial sessions as well as applications-oriented sessions that may be of interest to industrial participants. Please consult the Final Program for last minute changes to the technical program.

Plenary Lecture I   **Wednesday, June 24**
Dr. Herbert Hanselmann, President of dSPACE, GmbH   **8:30 am - 9:30 am**
Real-Time Control Systems - From Concept to Experiment to Product   **Grand Ballroom C & D, Exhibit Level**

This presentation highlights the development process of complex and fast Real-Time Control Systems using examples from automotive control. A common idealization of the process is the so-called V-model. It starts out with a specification of what should be achieved, then progresses via Design and Rapid Control Prototyping for proof-of-concept, down to the prototype of a production control module that will be subject to restrictions of processing power and memory. From there the process goes up the right-hand branch of the V-model via verification and validation to a finished and quality-assured product.

Modern tools need to support this complete development process in an integrated environment. This is the only way to meet the stringent time-to-market and quality requirements in competitive industries. Tools also change the way such development processes are distributed among disciplines or departments. The control design team itself can now cover most parts of the development process. There is no need anymore to stop at off-line simulation and hand-over the rest of the process to other departments, leading to inefficiencies and errors. Even the generation of production code for low-cost high-volume

applications is within the reach of such tools, and so within reach for the control design team, that now can develop a new control system from start to finish.

Dr. Herbert Hanselmann was born in the Southwest of Germany. He received the Diploma degree in Electrical Engineering in 1973 and a Dr. degree in 1978 from the Technical University of Karlsruhe, for work on computer-aided control system design. He then moved to the University of Paderborn, Mechanical Engineering Department, to help establish a new institute focusing on control design and implementation in mechatronics. The need for easy-to-use control-oriented tools to transfer designs to fast real-time processors was recognized in 1981. The ensuing developments led to the foundation of dSPACE GmbH in 1988, a company specializing in tools for the control engineer, where Dr. Hanselmann serves as President.

Plenary Lecture II   **Thursday, June 25**
Professor Jeff S. Shamma, University of Texas, Austin   **8:30 am - 9:30 am**
Gain Scheduling   **Grand Ballroom C & D, Exhibit Level**

Gain scheduling is a popular nonlinear control design method which is used in a variety of applications. The main idea is to construct a nonlinear control design by piecing together several linear control designs. This procedure combines conceptual simplicity with the intuitive appeal of utilizing familiar linear design tools. However, traditional gain scheduling also introduces possibly adverse effects due to fast transitions between design points, neglected nonlinearities, and hidden feedback loops. Despite its widespread application, gain scheduling had received relatively little analytical attention. Over the past few years, this situation has changed and new techniques for the analysis and design of gain scheduled control systems have emerged. This talk presents an overview of gain scheduling, discusses limitations associated with traditional gain scheduling, and reviews new approaches to gain scheduled control design.

Jeff S. Shamma was born in New York, NY, in November 1963, and raised in Pensacola, FL. He received the Ph.D. degree in 1988 from the Massachusetts Institute of Technology, Department of Mechanical Engineering. After one year of postdoctoral research, he joined the University of Minnesota, Minneapolis, where he was an Assistant Professor of Electrical Engineering from 1989 to 1992. He then joined the University of Texas, Austin, where he is currently an Associate Professor of Aerospace Engineering. His main research interest is robust control for linear parameter varying and nonlinear systems. He is a recipient of the 1992 NSF Young Investigator Award, and the 1996 Donald P. Eckman Award.

Plenary Lecture III   **Friday, June 26**
Dr. Babatunde Ogunnaike, E. I. du Pont de Nemours and Co.   **8:30 am - 9:30 am**
Controlling Industrial Chemical Processes   **Grand Ballroom C & D, Exhibit Level**

The fundamental premise of process control is that the natural response of all dynamic processes can be modified by the influence of a controller. The objective is therefore to design and implement the controller in such a way that the dynamic response is modified appropriately, in a desired fashion; but the extent to which the natural response can be modified appropriately will usually be determined by (i) the depth of our knowledge of the intrinsic process characteristics, (ii) the versatility of the hardware elements available for implementing the control system, and (iii) the nature of inherent process limitations. The chemical process–a single processing unit, or combinations thereof, used for the conversion of raw materials (and energy) into a finished product–is typically extremely complex, and often poorly understood at a fundamental level. Furthermore, the current economic/environmental climate dictates that these processes must now operate under conditions of very stringent demands on product quality, energy utilization, and safety and environmental accountability. In most cases, the key product quality variables still cannot be measured on-line; tighter energy integration has led to even more complex process interconnections; and the drive for waste minimization and emissions reduction often requires process operation at or near thermodynamic limits. In addition, the chemical process industry as a whole is in fact not homogenous: it is a very broad and diverse industry with various major segments–such as Oil/Gas/Petrochemicals, Specialty/Commodity Chemicals, Food/Pharmaceuticals/Agrochemicals, etc.–and the processes typically encountered in each segment have distinct distinguishing characteristics. These are some of the main factors that determine the nature of process control theory and practice. The discussion will provide an overview of the essential problems and challenges of industrial chemical process control and how these challenges are currently being met, illustrating key aspects with appropriate industrial examples.

Dr. Babatunde A. ("Tunde") Ogunnaike was born in Nigeria. He received the B.Sc. degree (with First Class Honors) in Chemical Engineering from the University of Lagos, Nigeria, in 1976; the M.S. degree, in Statistics from the University of Wisconsin-Madison in 1981; and the Ph.D. degree in Chemical Engineering also from the University of Wisconsin-Madison in 1981. From 1981 to 1982, he was a Research Engineer with the Process Control group of the Shell Development

Corporation in Houston, Texas; and from 1982 to 1988 he was a professor at the University of Lagos with joint appointments in the Chemical Engineering and the Statistics Departments. He joined the Advanced Control and Optimization group of DuPont Central Science and Engineering in 1989 where he is currently a Research Fellow. Also, since 1989, he has been an Adjunct Professor in the Chemical Engineering Department of the University of Delaware. He is the co-author of the textbook *Process Dynamics, Modeling and Control*, published in 1994 by Oxford University Press. His research interests include modeling and control of polymer reactors, identification and control of nonlinear systems, applied statistics, and reverse engineering biological control systems for process applications.

Tutorial Workshops

Eight tutorial workshops have been selected from a large set of proposals. Detailed summaries of all workshops appear later; the titles, presenters and dates are listed below.

1. Active Control of Vibration, Noise and Structural-Acoustic Interaction   Monday and Tuesday
    Dennis Bernstein, Ravinder Venugopal, Rob Clark, Jeff Vipperman   June 22 and 23

2. System Modeling and Simulation with MATLAB and Simulink   Monday and Tuesday
    Haik Biglari   June 22 and 23

3. Fundamental Limitations in Filtering and Control   Monday
    Graham Goodwin, Jim Freudenberg, Rick Middleton, Julio Braslavsky, Maria Marta Seron   June22

4. Canceled   Canceled

5. Identification of Uncertainty Models for Robust Control Design   Tuesday
    Mario Milanese, Paul M. J. Van den Hof   June 23

6. State-Dependent Riccati Equation Techniques: Theory and Applications   Tuesday
    James R. Cloutier, Curtis P. Mracek, D. Brett Ridgely, Kelly D. Hammett   June 23

7. Integrated Design of Controlled Engineering Systems   Tuesday
    R. E. Skelton, K. M. Grigoriadis, T. Iwasaki   June 23

8. Industrial Applications of Control: Issues and Opportunities for Research   Saturday (morning)
    Tariq Samad   June 27

9. Aerospace Structural Dynamics and Control   Saturday
    Richard Colgren, Jerzy Z. Sasiadek   June 27

The workshop presenters are technical leaders and experienced lecturers. Workshop registration fees, which include lecture notes and refreshments, may be paid in advance using the Advance Registration Form or on-site at the Registration Desk. Pre-registration is strongly encouraged, both to reserve space and to prevent workshop cancellation. A workshop will be canceled if the number of registrants does not meet a specific limit. In the unlikely event that a workshop is canceled, pre-registrants will be contacted as soon as possible after the advance registration deadline of May 8; therefore, when registering, please include your email address, telephone and fax numbers.

Exhibits   **Wednesday (6/24) & Thursday (6/25), 9:00 am - 5:30 pm**
Exhibition Center, Exhibit Level   **Friday (6/26), 8:30 am - 1:00 pm**

Exhibits will be sponsored by book publishers and developers of control systems software and hardware products. Coffee and soft drinks will be available in the exhibit area several times a day. For information concerning arrangements for the exhibits, contact the Exhibits Chair Jacob Apkarian (jacob@quanser.com).

CONFERENCE INFORMATION

Registration   **Sunday-Saturday, June 21-27**

Registration Desk, Exhibit Level **Hours shown below**

All conference attendees must register; personal badges will be provided to identify registered participants. Registration fees may be paid in advance using the enclosed Advance Registration Form. Advance registration is highly recommended. It saves you money, it provides a convenient way to ship your Printed Proceedings, and it helps to prevent cancellation of, or lack of space in, the Tutorial Workshops that you wish to attend.

The basic registration options are shown below. In addition, registered participants can have Printed Proceedings shipped to a US address ($15 each), purchase additional copies of the CD-ROM Proceedings ($30 each) or Printed Proceedings ($150 each), purchase additional tickets to the Awards Banquet ($40 each), take an excursion to Brandywine River Museum and Longwood Gardens ($35 each), or enroll in any of the 8 Tutorial Workshops (fees shown later).

Registration Categories	Advance Fee Before May 8	On-Site Fee June 21-27	CD-ROM Proceedings	Printed Proceedings	Awards Banquet	Social Receptions
Member - Full	$320	$385	yes	yes	yes	yes
Member - Reduced	$270	$335	yes	no	yes	yes
Non-Member - Full	$385	$470	yes	yes	yes	yes
Non-Member - Reduced	$335	$420	yes	no	yes	yes
Student or Retiree	$65	$80	yes	no	no	yes

A registration packet will be available for each registered participant at the Registration Desk during the following periods.

	Registration Desk Hours	
Sunday	June 21	6:00 pm - 8:00 pm
Monday	June 22	7:30 am - 12:00 noon
Tuesday	June 23	7:30 am - 9:00 pm
Wednesday	June 24	7:30 am - 6:00 pm
Thursday	June 25	7:30 am - 5:00 pm
Friday	June 26	7:30 am - 12:00 noon
Saturday	June 27	7:30 am - 9:30 am

Payment of fees must be made in US currency by check, money order, or credit card. Purchase orders, bon de commandes, bank transfers or promissory notes will <u>not</u> be accepted. Advance registration by fax or email will <u>not</u> be accepted. Advance registration must be received no later than May 8, 1998, or else it will <u>not</u> be processed. Refund requests will be honored only if they are received in writing no later than May 29, 1998. All questions concerning conference registration should be directed to the Registration Chair, Edwin Chong (echong@ecn.purdue.edu).

Speakers' Breakfast **Wednesday-Friday, June 24-26**
Adam's Ballroom A & B, Lobby Level **7:15 am - 8:15 am**

Complimentary breakfast will be served for speakers, chairs and co-chairs on the day of their sessions. Speakers should attend the breakfast in order to facilitate session planning, and to provide biographical information to the session chairs or co-chairs. For papers with multiple authors, only the presenting author is invited to attend the breakfast.

Conference Proceedings

The CD-ROM Proceedings will be distributed at the conference. Participants who register by May 8, 1998 may have their Printed Proceedings mailed directly from the printer to the address specified on their Advance Registration Form for $15, but only if this is a US address (PO Boxes not allowed). Otherwise, Printed Proceedings must be claimed at the Registration Desk; shipment from the conference hotel may be arranged by paying a fee and filling out a form.

Local Arrangements

For information on local arrangements within the hotel, contact the Local Arrangements Chair, Harry Kwatny (hkwatny@coe.drexel.edu). Requests for meeting rooms should be made in advance with details regarding room specifications, date, time, number of attendees, and any special requirements.

SOCIAL EVENTS

Welcoming Reception   **Tuesday, June 23**
Adam's Ballroom A & B, Lobby Level   **6:00 pm - 8:00 pm**

There will be a Welcoming Reception (cash bar) for all conference attendees and their accompanying guests. A ticket for one complimentary drink is included with each full registration packet.

Companions Orientation   **Wednesday, June 24**
Quincy's   **9:00 am - 10:00 am**

A brief orientation session will be held to provide an informal opportunity for accompanying guests to become better acquainted and to learn more about the city's tours, shopping, and the surroundings. Refreshments will be served.

Local Information   **Wednesday, June 24**
Registration Area, Exhibit Level   **9:00 am - 4:00 pm**

Information about sightseeing, tours and restaurants will be available at a table staffed by the Philadelphia Convention and Visitors Bureau. Note that this opportunity exists for just one day.

Newcomers & Students Reception   **Wednesday, June 24**
Exhibition Center, Exhibit Level   **6:30 pm - 7:30 pm**

ACC attendance always includes a number of students and first-time attendees. There will be a special reception to welcome those participants. Industrial participants are especially encouraged to attend this reception, since it provides a good opportunity to meet with students who will be seeking employment. Prize winners of the Student Design Competition will be determined during this reception. AACC officers and organizers of the conference will be on hand to answer questions about ACC and AACC.

Social Tour   **Thursday, June 25**
Brandywine River Museum & Longwood Gardens   **9:00 am - 5:00 pm**

There will be a tour to the Brandywine River Museum and the Longwood Gardens, located about an hour southwest of Philadelphia. The Brandywine River Museum, a 19th-century gristmill, houses an unparalleled collection of Wyeth family art, including works by N. C., Andrew, and James Wyeth. The horticulture display of Longwood Gardens on 1,050 acres offers manicured gardens, glass-enclosed conservatories, ancient trees, and summer waterlilies. Participants will be transported to and from the hotel by chartered buses. Dress casually and comfortably. Tickets may be ordered (before May 8, 1998) using the Advance Registration Form; they may also be purchased at the Registration Desk until 1:00 pm on Wednesday, June 24, subject to availability. The cost is $35 per person, which includes transportation and admission, but not lunch. Please make your reservation early, as the event may be canceled if not enough people pre-register for it.

Awards Banquet   **Thursday, June 25**
Grand Ballroom C & D, Exhibit Level   **7:00 pm**

The Awards Banquet will feature the presentation of annual awards sponsored by the AACC and remarks from the AACC President Masayoshi Tomizuka. Extra banquet tickets may be ordered (before May 8, 1998) using the Advance Registration Form; they may also be purchased at the Registration Desk until 1:00 pm on Wednesday, June 24, subject to availability. The price is $40 per person. If you plan to skip the Awards Banquet, please return your ticket as early as possible to the Registration Desk; returned tickets will be made available to students or retirees who would like to attend.

Closing Reception   **Friday, June 26**
Grand Ballroom C & D, Exhibit Level   **6:00 pm - 8:00 pm**

The Closing Reception will be a special time to relax after a hectic week, to enjoy special refreshments, to say good-bye to friends, and to make plans for the 1999 ACC. All registrants and their accompanying guests are invited.

The Adam's Mark Hotel is located 6 miles (15 minutes driving) from Center City. A courtesy trolley will be provided to take participants and their companions to Center City and back. The trolley will provide historical commentary and literature on board. Stops include the Art Museum, Franklin Institute, Independence Hall, and Old City. Even if you are not going to Center City for sightseeing and shopping, it is fun to just ride the trolley and come back to the hotel without de-boarding. A trolley schedule will be included in your registration packet.

STUDENT PROGRAMS

Best Student Paper Award

In keeping with tradition, the 1998 ACC solicited nominations for the Best Student Paper Award competition. There were 23 nominations this year. The nominated papers went through the usual review process and, in addition, were also reviewed by a panel from within the Program Committee. Based on the reviews, the following 5 papers (listed alphabetically) have been selected as finalists for the Best Student Paper Award competition:

Hua Deng and Miroslav Krstic, "Stabilization of Stochastic Nonlinear Systems Driven by Noise of Unknown Covariance," University of California, San Diego, CA (Session WA11-2).

Mohamed Seddik Djouadi and George Zames, "On Optimal Robust Disturbance Minimization," McGill University, Montreal, Canada (Session TA08-1).

Nikolaos V. Fourligkas and Charalabos Doumanidis, "Thermal Distribution Control in Scanned Processing of Materials," Tufts University, Medford, MA (Session TA01-4).

Jihao Luo and Panagiotis Tsiotras, "Control Design for Systems in Chained Form with Bounded Inputs," University of Virginia, Charlottesville, VA (Session WM01-5).

John J. Westman and Floyd B. Hanson, "The NLQGP Problem: Application to a Multistage Manufacturing System," University of Illinois, Chicago, IL (Session WP08-2).

The winner will be decided based on the reviews conducted thus far and the presentation of the paper at the ACC. All papers will be presented by the (first-listed) student authors. Please attend these sessions to encourage the presenters.

Student Design Competition

A new feature of the 1998 ACC is a student design competition. The competition is open to undergraduate students and masters students who will not graduate before April 1, 1998. The student must be sponsored by a faculty member at the school in which the student is registered. The objective is to design a controller for the Ball and Beam system. The controller design is submitted as a Simulink file. For an entry to be accepted, it must meet the design criteria. A random draw will determine the grand-prize winner from the accepted entries. The grand-prize is a data acquisition board awarded to the winner's school. Students with accepted entries who do not win the random draw will have the opportunity to win book prizes. This competition is sponsored by Quanser Consulting. Details should be obtained from:

http://www.quanser.com/acc98/ or http://www.rpi.edu/~bequeb/ACC98/

GENERAL INFORMATION

Adam's Mark Hotel

A block of rooms has been reserved at the Adam's Mark Hotel from Saturday, June 20, through Saturday, June 27. Daily room rates are $115 for single-occupancy, $125 for double-occupancy, and $10 for an extra person. Children under 16 stay free with an adult in the same room. All rooms are subject to a 13% room tax. Hotel parking is available for $3 per day.

Valet parking at $12 per day provides greater convenience and security. Reservations should be made by May 26; you may use the enclosed Hotel Registration Form or simply call 800-444-2326 (mention 1998 ACC). Reservation cancellations must be received 24 hours prior to scheduled arrival in order to avoid charges.

Adam's Mark Hotel	Tel:	215-581-5000
City Avenue and Monument Road	Fax:	215-581-5069
Philadelphia, Pennsylvania 19131	Reservations:	800-444-2326

The Adam's Mark Hotel is located on the outskirts of Philadelphia. It has two restaurants: The Marker and Appleby's. The Health Club offers two swimming pools, racquetball courts, and an exercise room. Fax machines and photocopying are available at the Business Center (inquire at the front desk). Two shopping centers are within walking distance: Two Bala Plaza and the Bala Cynwyd Shopping Center. There are also a dozen restaurants close to the hotel.

Transportation

The Philadelphia International Airport is 12 miles from the Adam's Mark Hotel. Shuttle service to the Adam's Mark Hotel is provided by Super Shuttle, available at the Ground Transportation Desk outside the Baggage Claim Area. Use the phone at the desk to dial 43 to arrange for pickup. The cost is $10 each way. To return to the airport from the Adam's Mark Hotel, call Super Shuttle at 215-551-6600 to make a reservation.

Philadelphia can also be reached by Amtrak from all major East Coast cities.

Special Airfare and Car Rental Discounts

We have arranged for discount airfares through US Airways for round trip travel to Philadelphia during the period June 19-29. To take advantage of these discounts, or for your other travel arrangements, contact the official 1998 ACC travel agency, Anina Travel Service, by phone at 1-800-792-5064 (within USA) or 1-312-263-2129, or by fax at 1-312-263-3924, or call US Airways' Meeting and Convention Desk at 1-800-334-8644. When calling, refer to Gold File Number 49640489 with group name American Control Conference.

We have also arranged for special car rental discounts, valid from June 15 to July 3, through Hertz. To take advantage of this discount, contact Anina Travel Service, or any Hertz Reservation Office worldwide. In the USA, the Hertz phone number is 1-800-654-2240. Refer to meeting number CV41919 or to the 1998 American Control Conference.

Philadelphia and Vicinity

"America's most historic square mile" is the front door to the family fun and excitement of Philadelphia's Waterfront and Historic Park. Begin your visit at the Visitors Center (3rd & Chestnut Streets, 215-597-8974). Then visit the Liberty Bell Pavilion, Independence Hall, Congress Hall, Old City Hall, Second Bank of the United States, New Hall Military Museum, Carpenter's Hall, and Franklin Court. The Park's buildings are open from 9 am to 5 pm and admission is free.

At the Waterfront, the Independence Seaport Museum (Columbus Blvd. & Walnut St., 215-925-5439) offers visitors America's maritime heritage through fun, interactive exhibits. Visitors can board an 1898 flagship, USS Olympia, and a WW II submarine, USS Becuna. The visit can continue with the Delaware Riverbus Ferry to the New Jersey State Aquarium at Camden.

Beginning at the Benjamin Franklin Parkway, Fairmont Park encompasses more than 8,900 acres of winding creeks, rustic trails, and lush green meadows. Notable sites in the park are the Waterworks, Lemon Hill Mansion, and the Horticulture Center (including the Japanese House and Gardens). The Philadelphia Museum of Arts and the Franklin Institute Science Museum are both located on Benjamin Franklin Parkway.

Within reasonable driving distance from the Adam's Mark Hotel is the Valley Forge National Historical Park with 3,600 acres to explore by car, bus, biking, or hiking. Visit the National Memorial Arch and Washington's Headquarters. One can also visit Lancaster, the center of Pennsylvania Dutch Country.

Dining

There are several restaurants in and around the hotel. Participants can also try the restaurants in the following areas: Manayunk (6 minutes by cab), Art Museum Area (10 minutes by cab), Center City (15 minutes by cab), and Old City (20 minutes by cab).

Climate

The average temperature in June ranges between a low of 63° F (17° C) to a high of 81° F (27° C). The average rainfall in June is 3.2 inches.

Room Sharing

If you would like to share a hotel room and need assistance finding a roommate, send an email to Fahmida Chowdhury (fnchowdh@usl.edu). In your message, mention the following: 1) your gender, 2) smoking preference, 3) exact dates you will attend the conference, 4) your email address, 5) your phone number, 6) anything else that you think is important. Lists will be compiled (one for male, one for female) and circulated every two weeks until one week before the conference.

Web Sites

For information on ACC: http://www.rpi.edu/~bequeb/ACC98/
For information on AACC: http://web.eecs.nwu.edu/~ahaddad/aacc/

TUTORIAL WORKSHOPS

Eight tutorial workshops are being offered. They take place on Monday and Tuesday, June 22-23, before the conference, and on Saturday, June 27, after the conference. The costs, descriptions, and schedules are summarized below.

	Attending ACC	Not Attending ACC	Student or Retiree
Workshop 1 (2 day)	$495	$575	$255
Workshop 2 (2 day)	$405	$485	$165
Workshop 3 (1 day)	$270	$325	$110
Workshop 4 (canceled)	n/a	n/a	n/a
Workshop 5 (1 day)	$270	$325	$110
Workshop 6 (1 day)	$270	$325	$110
Workshop 7 (1 day)	$270	$325	$110
Workshop 8 (1/2 day)	$180	$215	$70
Workshop 9 (1 day)	$270	$325	$110

Tutorial Workshop 1: Active Control of Vibration, Noise and Structural-Acoustic Interaction

Dennis Bernstein   University of Michigan
Ravinder Venugopal   University of Michigan
Rob Clark   Duke University
Jeff Vipperman   University of Maine

This two-day workshop will provide attendees with a detailed and in-depth overview of methods and technology pertinent to active control of vibrations and acoustics. The course will also encompass applications involving structural-acoustic interaction. An important feature of the course is its balance between theoretical issues and technological implementation. The first day of the workshop is devoted to the physics of vibrations and acoustics, design aspects of practical sensors and actuators for active vibration suppression applications, and both fixed-gain and adaptive control methods. The second day of the workshop focuses on relevant technology including hardware implementation issues, system identification techniques, and programming of DSPs. The workshop closes with hardware demonstrations of noise and vibration suppression techniques on two separate testbeds, one involving structural vibration and the other devoted to acoustic noise cancellation. This workshop is designed to be of value to attendees with diverse backgrounds. Researchers seeking to construct a controls laboratory involving noise and vibration control experiments will be exposed to fundamental hardware and equipment issues. In

addition, industrial practitioners will obtain an overview of the latest advances in vibration suppression technology relating to design and implementation techniques.

Monday, June 22
08:30 - 10:30	Vibrations, acoustics, and structural-acoustic interaction for control engineers
11:00 - 12:00	Control engineering design aspects of sensors and actuators
13:00 - 15:00	Fixed-gain control methods for vibrations and acoustics
15:30 - 17:30	Adaptive control methods for vibrations and acoustics

Tuesday, June 23
08:30 - 09:30	Hardware for vibrations and acoustics
09:30 - 10:30	Sampling and discretization effects in data acquisition and control
11:00 - 12:00	Time-domain identification for vibrations and acoustics
13:00 - 14:00	Frequency-domain identification for vibrations and acoustics
14:00 - 15:30	Programming essentials for DSP hardware
16:00 - 17:30	Hardware demonstrations of active vibration and acoustic control

Tutorial Workshop 2: System Modeling and Simulation with MATLAB and Simulink

Haik Biglari   *The Boeing Company*

This two-day workshop provides hands-on training in modeling and simulation of dynamical systems. It is designed for engineers, scientists, and managers involved in design of complex multi-disciplined dynamic systems in the emerging field of mechatronics engineering. The course begins with an overview of the MATLAB and Simulink environments and includes simulations of several distinct disciplines. Upon completion of the workshop, attendees will be able to develop and analyze MATLAB programs and Simulink block diagram representations of dynamic systems. Each attendee will have access to MATLAB and Simulink on a PC during the workshop. In addition, the instructor's CRT will be projected onto a screen for attendees to view and thereby be able to compare their simulation results. The final project involves design and analysis of a Magnetic Suspension Seismometer.

Monday, June 22
08:30 - 10:00	Fundamentals of MATLAB and Simulink
10:30 - 12:00	Modeling in MATLAB and Sequential Languages
13:00 - 14:30	Development of Hierarchical Simulink Models
15:00 - 17:00	Selected Examples

Tuesday, June 23
08:30 - 10:00	Time Domain and Frequency Domain Simulations
10:30 - 12:00	Analysis of Dynamic Systems
13:00 - 14:30	Analysis and Design of Control Systems
15:00 - 17:00	Final Project: Magnetic Suspension Seismometer

Tutorial Workshop 3: Fundamental Limitations in Filtering and Control

Graham Goodwin	*University of Newcastle, Australia*
Jim Freudenberg	*University of Michigan, Ann Arbor*
Rick Middleton	*University of Newcastle, Australia*
Julio Braslavsky	*University of Newcastle, Australia*
Maria Marta Seron	*University of Newcastle, Australia*

This workshop discusses fundamental limitations in achieving performance in control and filtering systems. An important part of any design process is characterization of the best achievable performance from the system in terms of its intrinsic dynamics and structure. This analysis reveals what is, and is not, possible prior to application of any specific design technique. This knowledge allows rational tradeoffs of desirable, but often incompatible features in design specifications, or, when feasible, to alter the system configuration to alleviate the most critical constraints, e.g. by changing actuator/sensor arrangements.

A well-known framework for analyzing design limitations uses frequency domain sensitivity functions which describe system performance and robustness. Limitations are then expressed as integral formulas (Bode and Poisson integrals) that arise from the analyticity of the sensitivity functions. An alternative, state-space approach is to study the best achievable performance of optimal control when the cost of control tends to zero (cheap control). This line of research, which has insightful connections with Bode integrals, has been recently extended to the analysis of performance of nonlinear systems. This workshop provides a comprehensive overview using both approaches. It includes classical results as well as a selection of the most recent contemporary extensions to multivariable systems, sampled-data, filtering, and nonlinear problems. Use of these techniques in engineering practice is illustrated with several industrial applications, including control of a single strand rolling mill.

Monday, June 22

08:30 - 09:15	Motivation and history.
09:15 - 10:00	Time-domain analysis of tradeoffs. Application: Rolling mill.
10:30 - 11:15	Frequency-domain limitations in SISO control.
11:15 - 12:00	Limitations in filtering: frequency-domain and optimal approach.
13:00 - 15:00	Limitations in MIMO control. Automotive applications.
15:30 - 16:15	Limitations in sampled-data control.
16:15 - 17:00	Limitations in achievable L-2 performance in linear and nonlinear control.

Tutorial Workshop 4: Canceled

Tutorial Workshop 5: Identification of Uncertainty Models for Robust Control Design

Mario Milanese   Politecnico di Torino
Paul M. J. Van den Hof   Delft University of Technology

This workshop illustrates recently developed Set Membership (SM) methods for identifying models in a suitable form for robust control design. Robust control methods aim to design controllers which guarantee performance not for a single nominal model, but for a set of models (obtained by perturbations of the nominal model). Such perturbations recognize that models derived by any identification method are always affected by uncertainty. If the design methods are to be used in real world problems, the uncertainty model set must be provided by suitable SM identification methods, operating on measurements of the actual plant and on available prior information about the plant and the noise affecting its measurements. For example, H-infinity identification estimates a model and an identification error (the H-infinity norm of the error transfer function) which produces uncertainty model sets in a form well suited for the H-infinity control methodologies.

This workshop emphasizes two main aspects of the identification-control problem: (1) Obtaining "tight" uncertainty models, essential for obtaining "high" guaranteed control performances, and (2) Evaluating the effect of low complexity (order) models and controllers on guaranteed control performances. The overall identification-control procedure presented in this workshop consists of: validation of prior information; approximate model identification and modeling error evaluation; robust control design; robust performance evaluation; tradeoffs between model and controller complexity and achievable robust closed loop performance levels. Methods and algorithms using this procedure are presented for different experimental conditions (time or frequency measurements, open or closed loop experiments) and noise assumptions (point-wise or energy deterministic bounded, stochastic with finite support pdf). Applications to real problems will also be presented.

Tuesday, June 23

08:30 - 09:00	Preliminaries and motivations for a SM approach
09:00 - 10:00	General SM identification theory
10:15 - 11:00	SM identification from time open loop data
11:00 - 12:00	SM identification from frequency open loop data
13:00 - 13:30	Validation of prior assumptions
13:30 - 14:15	Identification of "soft" uncertainty models
14:30 - 15:30	SM identification from closed loop data
15:30 - 16:30	Robust control design and robust performance evaluation
16:30 - 17:30	Applications (flexible structure, CD player, wafer stepper)

Tutorial Workshop 6: State-Dependent Riccati Equation Techniques: Theory and Applications

James R. Cloutier   *Eglin Air Force Base, Florida*
Curtis P. Mracek   *Eglin Air Force Base, Florida*
D. Brett Ridgely   *Hughes Missile Systems Company & Directed Energy Directorate, Arizona*
                                    Kirtland Air Force Base, New Mexico
Kelly D. Hammett   *Hughes Missile Systems Company & Directed Energy Directorate, Arizona*
                                    Kirtland Air Force Base, New Mexico

This workshop (1) informs control practitioners of the capabilities and effectiveness of State-Dependent Riccati Equation (SDRE) design techniques and (2) draws more theoreticians into the area so the gap between successful applications of these methods and the theory supporting them can be narrowed. SDRE techniques are rapidly emerging as general design methods which provide a systematic and effective means of designing nonlinear controllers, observers, and filters. In this methodology, nonlinear systems are first parameterized to a linear structure having state-dependent coefficients (SDC). Control or filter design is then completed for the parameterized system. This workshop focuses on four SDRE methods: SDRE nonlinear regulation, SDRE "nonlinear H-2" control, SDRE "nonlinear H-infinity" control, and SDRE nonlinear filtering.

All of the theory developed to date on SDRE regulation is presented starting with conditions that guarantee local asymptotic stability. Optimality and sub-optimality conditions and properties are covered, the non-uniqueness of the SDC parameterization is described, and it is shown how the SDC parameterization itself can be parameterized. Design approaches are reviewed, and the capabilities of SDRE design methodology are highlighted, including the ability to impose hard bounds on control, control rate, or even control acceleration and the capability to directly handle unstable non-minimum phase systems. Numerous examples are used to illustrate the methodology. Conditions and special cases that yield global and semi-global asymptotic stability of the closed-loop system will be covered. Controllability issues are then presented including differences and similarities between SDC factored point-wise controllability and true nonlinear controllability.

The remaining SDRE methods are treated similarly. For the full state information case, it is shown that the SDRE "nonlinear H-infinity" controller produces a local solution of the sub-optimal nonlinear H-infinity control problem. The effectiveness of SDRE "nonlinear H-2" control is illustrated through a full envelope missile pitch auto-pilot design. Finally, the filtering aspect of the SDRE methodology is illustrated using several examples; it is shown how the non-uniqueness of the SDC parameterization can be used to avoid singularities or avoid loss of observability.

Tuesday, June 23
08:30 - 09:00   Introduction
09:00 - 10:15   SDRE Nonlinear Regulation: Stability, Optimality, Sub-optimality
10:30 - 12:00   SDRE Nonlinear Regulation: Examples
13:00 - 14:45   SDRE Nonlinear Regulation: Sampled Data, Controllability
15:00 - 15:45   SDRE "Nonlinear H-infinity" Control
15:45 - 16:30   SDRE "Nonlinear H-2" Control
16:30 - 17:00   SDRE Nonlinear Filtering
17:00 - 17:30   Summary

Tutorial Workshop 7: Integrated Design of Controlled Engineering Systems

R. E. Skelton   *University of California, San Diego*
K. M. Grigoriadis   *University of Houston*
T. Iwasaki   *Tokyo Institute of Technology*

The design of modern controlled engineering systems requires integration of mechanical and structural components, sensors and actuators, and finite precision controllers to produce total systems with desired performance characteristics. However, universities and textbooks traditionally treat design, structural dynamics, signal processing, and controls as separate, independent disciplines. Thus we know how to predict closed loop performance, given COMPONENT properties, but we do not know how to determine COMPONENT requirements from SYSTEM requirements. To find true limits of performance, and to design optimal total systems, an integrated approach to system design is required, where all resources (materials, structures, signal processing and controls) are optimized (or at least "sub-optimized") together rather than individually.

This workshop presents a scientific approach for integrating modeling, structural design, control synthesis and signal processing aspects in the design of controlled engineering systems. Issues include: i) How should closed-loop performance criteria affect system modeling decisions? ii) How to parameterize all combinations of plant and control design parameters to provide a desired achievable performance? iii) What is the effect of finite wordlength in the digital controller, and how to minimize it? iv) How to effectively redesign the plant and controller so that their dynamics "cooperate" to reduce the control energy required to achieve the required performance? v) How to select sensor and actuator types and locations? vi) How to integrate the design of the structure (geometry, mass, damping, and stiffness distribution), control (controller complexity and control gains) and the controller implementation (sensor and actuator characteristics, roundoff errors, signal processing effects)? (vii) How to find the most economical solution (the smallest signal to noise ratio in each component to guarantee a specified level of system performance)?

Case studies and design examples will be presented to demonstrate the benefits and capabilities of the integrated design formulation. Examples include: Hubble Space Telescope controller, vibration isolation problems, controllable civil engineering structures, and new smart structure concepts, controllable tensegrity structures.

Tuesday, June 23

08:30 - 09:00	Introduction and basic concepts - need for a theory for design
09:00 - 10:00	Modeling, identification and design for control
10:15 - 11:00	Unified formulation of robust control problems
11:00 - 12:00	Design parametrization for achievable performance
13:00 - 13:30	Optimal mix of passive and active control (OMPAC software)
13:30 - 14:15	Design for controller implementation, LMI approaches
14:30 - 15:30	Finite signal-to-noise ratio models and control
15:30 - 16:30	Computational tools and iterative redesign methods
16:30 - 17:30	Design cases and examples - discussion

Tutorial Workshop 8: Industrial Applications of Control: Issues and Opportunities for Research

Tariq Samad　　　　　　　*Honeywell Technology Center*

This half-day workshop highlights technology transfer and application issues, discusses current control research trends from an industry perspective, and suggests promising avenues for industry-relevant controls research. The material is directed towards researchers interested in transferring technology from a research environment to industrial practice. Several of the non-technological factors involved in successful commercialization and broad-based application are discussed, including: marketing of new technology, support for maintenance and upgrades, and the necessary skill levels of users. Technology itself is just one piece of the puzzle, albeit a critical one. The importance of other technologies in control system solutions, including sensors, human interfaces, computing platforms, and communications are emphasized. These peripheral technologies are enablers for facilitating development of advanced control algorithms, but at the same time algorithmic research must take into account limitations of the existing infrastructure. The importance of domain knowledge will also be emphasized; general-purpose control science may be appropriate for academic coursework, but its application to real problems inevitably requires customization.

Based on insights gained from these big-picture considerations, the next topic reviews several major areas in control, focusing on those research and development issues that stand in the way of practical impact. These areas include: nonlinear control, adaptive control, system identification, and intelligent control; the discussion refers to domain-specific considerations in process control, environmental control, and other fields. Some particularly promising opportunities for control technology will also be discussed; there is considerable excitement within industry in areas such as hybrid models, large-scale optimization, and intelligent data analysis. Technical approaches that can furnish acceptable, fieldable solutions are needed.

Other topics, with suggestions and recommendations given as appropriate include: the structuring of mutually beneficial industry-university collaboration; the importance of, and avenues for, intellectual property protection; and consequences for the research community of the re-engineered corporation.

Saturday, June 27 (one-half day)

08:30 - 09:00	Motivation and overview: the role of technology in commercial products and services
09:00 - 09:30	The system consideration in control system developments

09:30 - 10:00	Industry perspectives on topics in control: nonlinear control, adaptive control, system identification, intelligent control
10:15 - 11:00	New opportunities for control technology: hybrid modeling, large-scale optimization, data mining
11:00 - 11:30	Some other topics: industry-university cooperation, intellectual property protection, impact of re-engineering
11:30 - 12:00	Summary and discussion

Tutorial Workshop 9: Aerospace Structural Dynamics and Control

Richard Colgren   *Lockheed Martin, California*
Jerzy Z. Sasiadek   *Carleton University, Canada*

This workshop presents a practical guide for control or structural engineers working on flexible vehicles and structures. The workshop begins with an introduction to dynamic modeling: differential equations, modal models, state space matrices, and distributed matrices. Computer programs for such models will be covered, with emphasis on Finite Element Modeling using NASTRAN or equivalent programs. Model reduction techniques include: residualization, truncation, reduced modal models, and state space reduction methods. The models will also be transformed for use in control system design. The control methods include: classical frequency domain methods and root locus, eigenvalue and eigenvector placement, optimal/robust control, and fuzzy control.

Following modeling and control system methodology, the workshop presents a practical design/validation process. It starts with stick model descriptions of the system that result in differential equations or other equivalent descriptions. Then finite element models are constructed which are linearized to generate a modal description. (Another possible approach is to generate a model using the assumed modes for the system.) This plant description is then reduced for use in the control system design process. A simple, linear representation of the control system is then implemented in the full structural dynamic model, for example in NASTRAN or the equivalent, for final verification of the design.

Example aeroservoelastic and large space structure applications are explored in the final part of the workshop. The aeroservoelastic example will be of an advanced supersonic transport (AST) with a long, slender fuselage resulting in relatively low frequency first and second fuselage bending modes. The large spacecraft example will be of a large radar satellite, which shows significant structural dynamics due to its large diameter antenna. Also, an example of a large antenna structure and of the flexible link of a robot will be shown.

Note: The textbook *Balanced Control of Flexible Structures* by Wodek Gawronski will be available for purchase at the Springer-Verlag booth in the exhibits area and is recommended to workshop participants.

Saturday, June 27
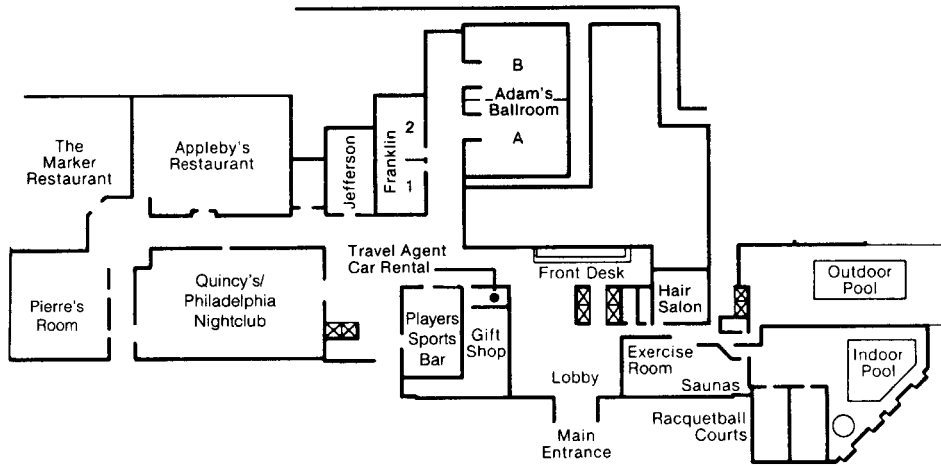| 08:00 - 08:30 | Welcome and Introduction |
08:30 - 10:00	Dynamic Modeling
10:15 - 12:00	Control Design Methods
13:00 - 14:30	Design/Validation Process
14:45 - 16:00	Example Applications
16:00 - 16:30	Conclusion and Wrap-up

HOTEL AREA MAPS
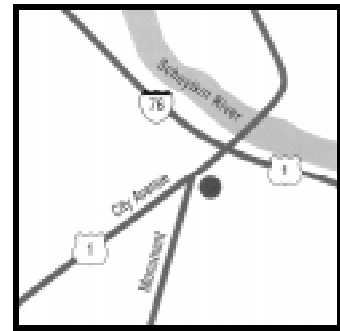
HOTEL FLOOR PLANS

Lobby Level

Exhibit Level