39th IEEE Conference on Decision and Control

December 12-15, 2000, Sydney Convention and Exhibition Centre

Sponsoring Organisation

IEEE Control Systems Society

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Society for Industrial and Applied Mathematics (SIAM)
Institute for Operations Research and Management Sciences (INFORMS)

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39th IEEE Conference on Decision and Control

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39th IEEE CONFERENCE ON DECISION AND CONTROL

Sydney Convention and Exhibition Centre, Sydney Australia
12-15 December 2000

I. GREETINGS FROM THE GENERAL CHAIR

Welcome to Australia and to Sydney on behalf of the IEEE Control Systems Society and the Operating Committee of CDC 2000. The 39th IEEE Conference on Decision and Control is being staged in the Southern Hemisphere for the first time. CDC is back in Summer for the only time since its inaugural manifestation as the Discrete Adaptive Processes Symposium of June 1962 in New York. This time however, Summer is in December and the event is marked for its international flavour. Somewhat appropriately, it follows just ten weeks after the close of the Summer Olympic Games in Sydney – as a curtain-raiser! Symbolically, it also concludes two weeks before the centenary of Australia as an independent nation on January 1, 2001.

CDC is the peak event of the annual Control Systems calendar. It is conducted under the auspices of the IEEE Control Systems Society in co-operation with the Society for Industrial and Applied Mathematics (SIAM) and the Institute for Operations Research and Management Sciences (INFORMS). The excitement of the Southern venue is indicated by a dramatically increased submission rate to the conference. Close to 1800 papers were contributed, with the bulk being in the categories of Full Papers and of Invited Sessions. We read this as indicating a very strong desire to attend the event and to present papers. This is an exceptionally large trawl, which, when combined with the limited number of parallel sessions permissible in the four-day program, has meant that the acceptance rate has been significantly lower than normal. A reflection of this is that the quality of the program is exceedingly high, with only papers scoring in the top ranges selected. While this has necessitated the increase above previous norms of the rejection rate, the ability of the Program Committee, under the guidance of Chair Cheryl Schrader and Vice-chairs Linda Bushnell and Ken Loparo, to be highly selective and to compose the best possible sessions is evident in the program. We think that you will notice this aspect immediately.

Plenary presentations from: Professor Hidenori Kimura on Brain Motor Control; Professor Allen Tannenbaum on Control/Computer Vision; and, Bode Lecturer Professor "Sagar" Vidyasagar on System Identification and Learning Theory, will provide strong intellectual challenges and stimulation. These are cutting edge subjects at the leading boundaries of the field. Complementing these technical addresses will be three special sessions devoted to Education, History and Commercialisation of our area. On Tuesday evening, we have a Special Session entitled "Reshaping Control Education for the 21st Century" which deals with the teaching of appropriately modern Control Systems. This is followed by a Special Session from Honeywell about the supply side of Control. Our intention is to provide some perspective and insight into an industry which survives by selling Control Systems rather than only by researching methodologies or by specific end utilisation. Early on Wednesday evening, a Plenary Panel will be convened to present the recent work in attempting to identify the twenty-five most seminal papers of control. This will be chaired by Professor Tamer Başar and presented by his expert panel.

In concord with the novel location and season, and following on from the challenging technical program, CDC 2000 is notable for breaking with some recent traditions in exploring different approaches and formats. For the first time, we have used a Professional Conference Organiser, Conference Action of Sydney, together with a smaller and more cohesive Operating Committee of volunteers. In part, this is to assist in setting up CDC at a distance but is also an experiment in using more directly experienced management. We have moved CDC to a purpose-built Convention Centre rather than using a hotel complex. A multitude of lesser changes have been tried. We would welcome your reaction.

Wednesday will have a four-hour lunch break to permit CDC attendees to enjoy the sunshine at the beaches of Sydney or on its famous Harbour on a luncheon cruise. This break has been inserted to assist in dealing with the four-day program and to allow delegates to meet with family and friends during the event. Of course, we have a particularly attractive panel session at the conclusion of the break to entice attendees back. The Conference Banquet will take place in The Ballroom on Thursday night after the separate Awards Ceremony in the Skyline Terrace. An insightful and entertaining speaker has been invited to address the banquet, which should prove engaging and of great interest.

As a native Sydneysider, it is my distinct pleasure to invite you to explore and enjoy "The City on the Harbour" at CDC 2000. It is a very welcoming and lively place. I am certain that all delegates and their friends and family will find Sydney able to cater to every taste. The food, live music, galleries, beaches and harbour should all be sampled. For people who pride themselves on sporting achievements, as evidenced in the recent Olympic Games, it has been noted that the enduring physical symbol of Sydney is a cultural icon, its Opera House. That is the nature of the place. Have a great time and don't forget to look to the right before stepping off the curb – seriously!

Bob Bitmead, General Chair.

II. CONFERENCE REGISTRATION

ON SITE REGISTRATION FEES (INCLUSIVE OF 10% GST)

Full Delegate (Members)	A$770
Full Delegate (Non Members)	A$880
Delegate (Reduced Rate*)	A$375

*Reduced Rate includes students, life members, retirees. Evidence of admissibility to this category needs to be provided.

DELEGATE ENTITLEMENTS:

- Attend all Conference sessions
- Receive morning/afternoon teas each day
- Receive a copy of the Conference Package including a Book of Abstracts, program and CDROM Proceedings.
- Welcome Reception
- Conference Dinner (only available to Reduced Rate Delegates at additional cost)
- Entry to exhibition area
- Farewell Reception

SPECIAL REQUIREMENTS

Should you have any special requirements eg. dietary or a disability, please indicate this on your registration form so that arrangements may be made on your behalf to ensure your requirements are accommodated.

DISCLAIMER OF LIABILITY

The Conference Organising Committee reserves the right to amend any part of the Conference program or event should it be necessary. IEEE and the Conference Secretariat, will not accept liability for damages of any nature sustained by participants or their accompanying persons, or loss of, or damage to, their personal property as a result of the 39th IEEE Conference on Decision and Control or related events.

CDC REGISTRATION DESK

The CDC Registration Desk, located on Level 2, Convention Centre North, Sydney Convention and Exhibition Centre, will be open during the following hours:

Monday, 11 December: 4:00pm - 6:00pm

Tuesday, 12 December: 7:30am - 6:00pm

Wednesday, 13 December: 7:30am - 6:00pm

Thursday, 14 December: 7:30am - 6:00pm

Friday, 15 December: 7:30am - 12:00noon

Prior to these times, the Registration Desk will be located in the Blackwattle Bay Rooms, Mezzanine Level in the *Parkroyal Hotel*, and will be open (for both Workshop and Conference Registration) during the following hours:

Sunday, 10 December: 7:30am - 6:00pm

Monday, 11 December: 7:30am - 12:00pm

A registration packet containing all necessary materials and local information will be given to each attendee at the Registration Desk during its operation hours.

III. CONFERENCE PROCEEDINGS

Printed Proceedings will NOT be available on-site and are not included in the regular registration fee. Full registration plus inclusion of a printing and mailing fee will entitle the registrants to a hardcopy of the Proceedings mailed directly to their addresses in the weeks after the conference. The Conference Proceedings in electronic (CD-ROM) form will be available at the Conference to both full and reduced-rate registrants. Computers for reading the CD-ROM Proceedings will **not** be made available by the Conference organisers. However, third party providers such as local Internet Café's and Business Centres may be used. After the conference, copies of the printed Proceedings may be purchased at a price set by IEEE by directly contacting:

IEEE Service Center
445 Hoes Lane
Piscataway, NJ 08854 USA
800-678-4333 (or 908-981-1393)
http://www.ieee.org/ieeestore/ordinfo.html

IV. SOCIAL EVENTS

WELCOME RECEPTION - *MONDAY, 11 DECEMBER 2000*

Time: 6:00pm-8:00pm, Harbourside Room, Level 2 Sydney Convention and Exhibition Centre North.
Cost: (Inclusive for all Delegates) A$55.00 for guests (incl. GST)
The Welcome Reception will be held in the exhibition area, Harbourside Room, at the Sydney Convention and Exhibition Centre. We hope all delegates, partners and exhibitors will join us to celebrate the opening of the conference. Canapes and drinks will be served.

COMPANIONS ORIENTATION - *TUESDAY, 12 DECEMBER 2000*

Time: 9:00am-10:00am, Harbourside Meeting Room 1, Level 2 Sydney Convention and Exhibition Centre North.
Cost: None.
This will be a relaxed opportunity for companions accompanying delegates to meet and receive an orientation to the Convention Centre, the city and available tours. A morning tea will be served.

NEWCOMERS AND STUDENTS RECEPTION - *TUESDAY, 12 DECEMBER 2000*

Time: 6:10pm-7:00pm, Skyline Terrace, Level 3 Sydney Convention and Exhibition Centre North.
Cost: None.
This reception will welcome and orientate those who are attending their first CDC conference. Light refreshments will be served and conference organisers will be available to answer questions about the CDC and the Society.

SYDNEY HARBOUR LUNCHEON CRUISE - *WEDNESDAY, 13 DECEMBER 2000*

Time: 1:15pm-3:30pm
Cost: A$65.00 per person (incl. GST)
(Please note that numbers are limited to 500 on the two boats. The boats will depart from Convention Jetty Wharf, Darling Harbour adjacent to the Convention Centre, at 1:30pm.)
We have especially planned to have the afternoon free of sessions so you can enjoy this cruise around the world-renowned Sydney Harbour - a must for all visitors to Sydney! The cruise offers an unsurpassed sightseeing experience. Cruise past famous landmarks - the Opera House, Sydney Harbour Bridge, the Royal Botanic Gardens and Fort Denison. View exclusive homes, Taronga Zoo, Middle Harbour and an ever-changing city skyline. A buffet lunch is included in the cost.

BRIDGECLIMB BY DAY - THE SYDNEY HARBOUR BRIDGE - *WEDNESDAY, 13 DECEMBER 2000*

Time: from 2:00pm onwards (3 hour duration)
Cost: A$117 per person (incl.GST)
(Please note: Numbers are restricted to 70 and there are restrictions on blood alcohol level. All climbers must have a blood alcohol level of less than 0.05%)
Join us … for the climb of your life! We have made an exclusive booking for participants to this conference to enjoy the most memorable experience Sydney can offer - a climb to the top of the world famous Sydney Harbour Bridge by day! BRIDGECLIMB is a truly unique adventure. The Sydney Harbour Bridge is one of the engineering wonders of the world, and one of the most potent icons of the greatest harbour in the world. BRIDGECLIMB is a world first experience of the power and history of the Sydney Harbour Bridge. Come and feel the exhilaration of making your way over the catwalk to the pylon and then setting out up the arch on your way to the summit. Before you lies a spectacular 360 degree view of one of the greatest harbours…one of the greatest cities. It's something you will remember all your life.

AWARDS CEREMONY - *THURSDAY, 14 DECEMBER 2000*

Time: 6:45pm - 7:30pm
Location: Skyline Terrace, Convention Centre North, Level 3.
The Annual Awards Ceremony and presentations of the Control Systems Society will take place at a special event prior to the commencement of the Conference Dinner. This will include:

- Outstanding Paper Awards;
- Distinguished Member Awards;
- Outstanding Chapter Award;
- Control Systems Technology Award;
- Bode Lecture Prize;
- The Control Systems Award (to be presented by the IEEE President Bruce Eisenstein).

All conference registered delegates and their guests are welcome to attend this function. The function will be concluded in time for delegates and guests to attend the conference dinner.

CONFERENCE DINNER - *THURSDAY, 14 DECEMBER 2000*

Time: 7:45 - 11:30pm (Pre dinner drinks will be served at 7:15pm, Dinner will commence at 7:45pm)
Cost: (Inclusive for full Delegates) A$120.00 per person
Location: The Ballroom, Convention Centre South, Level 2
The Sydney Convention and Exhibition Centre will host the Conference Dinner. We hope all delegates and their guests will join us on this occasion to make it a memorable night of the Conference. Culinary and intellectual stimulation is assured with an International Australian flavour.

FAREWELL RECEPTION - *FRIDAY, 15 DECEMBER 2000*

Time: 5:00pm – 7:00pm
Cost: (Inclusive for all delegates) A$55.00 for guests (incl. GST)
Location: Skyline Terrace, Convention Centre North, Level 3.
All conference registered delegates are entitled to attend this function. Additional guests are very welcome but tickets must be purchased. Drinks will be served and there will be live entertainment.

V. CSS BOARD OF GOVERNORS MEETING

The semi-annual IEEE Control Systems Society Board of Governors meeting will be held in Harbourside Meeting Room 4, Level 2, Sydney Convention and Exhibition Centre on Monday, 11 December 2000 from 12:00 pm to 6:30 pm. This is an open meeting and all members of the Society are welcome to attend.

VI. SPEAKERS: Meeting your Session Chair

Speakers are required to meet in the session room 20 minutes before commencement of their session to confirm presenters' details with the chairs.

VII. EXHIBITS

Exhibits will be held in the Harbourside room, Convention Centre North, Level 2, as will the morning and afternoon refreshments. Exhibit hours are 9:30am-5:00pm Tuesday, 8:30am-5:00pm Wednesday and Thursday, and 8:30am-3:30pm Friday. The exhibitors include:

- Ceanet Pty Ltd (Matlab distributors)
- Pearson Education
- Birkhauser Boston / DA Information Services
- John Wiley and Sons Ltd
- SIAM
- Taylor and Francis Ltd
- Springer-Verlag

VIII. THE SITE AND LOCAL ARRANGEMENTS

CLIMATE

It's summer in Sydney in December, and you can expect the daytime weather to be warm to hot. Overall temperatures can be expected to range from 16C (61F) to 25C (77F), although there is some chance of temperatures up to 38C (100F). And don't forget to wear sunscreen…..

GOODS AND SERVICES TAX (GST)

The Australian Government has introduced a 10% Goods and Services Tax (GST) effective 1 July 2000. All prices quoted in this document include GST. There is a tourist refund scheme for GST on purchases taken out of Australia. This is described on the Australian Customs Service website at http://www.customs.gov.au/taxref/trs.htm. Please note that this refund scheme only applies to aggregate purchases over A$300 at any one store.

REGISTRATION

The Registration Desk will be located on Level 1 of the Convention Centre.

NAME BADGES

All delegates will be given a name badge at registration. This badge will be the official pass to sessions, teas, lunches and official functions, and for security reasons, you are required to wear your name badge at all times. Additionally, tickets will be issued for the receptions and dinner, and will be required for entry to these events.

REFRESHMENTS

Morning and afternoon teas will be served in the Trade Exhibition area in the Harbourside Room on Level 2 of the Convention Centre.

MESSAGES

A message board will be located near the Registration Desk.

SMOKING POLICY

It is illegal to smoke within the Sydney Convention and Exhibition Centre buildings.

CREDIT CARDS

Credit cards accepted at the Registration Desk are **Mastercard, Visa, and Australian Bankcard.** The majority of hotels, restaurants and specialty shops will also accept other major credit cards. Many of the local Automatic Teller machines will accept "Cirrus", "Maestro" and "Plus" compatible cards.

CURRENCY AND BANKING

Decimal currency is used in Australia and currency units are dollars and cents. Banks in Sydney are open 9:30am-4:00pm Monday to Thursday and to 5.00pm on Friday. Exchange facilities are available at major hotels and at airports throughout Australia. Automatic Teller Machines are open 24 hours and deliver Australian Currency. These machines are available at the Sydney Airport International terminal upon arrival.

ELECTRICITY

The electrical current is 240/250 volts AC50Hz. Most leading hotels provide 110 volt outlets suitable for shavers only.

TIME

In relation to Greenwich Mean Time, Sydney in December is +11 hours.

ENTRY REQUIREMENTS

All international visitors to Australia must be in possession of a valid Australian entry visa. See the Department of Immigration website at http://www.immi.gov.au/visitors/index.html for further information. Your Visa requirements should also be checked with your airline or travel agent.

HEALTH INSURANCE

We strongly advise you to take out an insurance policy to cover any unexpected medical or hospital expenses.

VACCINATIONS

A current valid international certificate of inoculation against yellow fever is required if passengers come from, or travel through, infected areas. Check this carefully with your airline or travel agent.

QUARANTINE

Australia is free from many plant and animal diseases prevalent in other countries. Very strict quarantine rules apply to the importation of food, animals, plants and their products which cannot be brought into the country without prior application.

CUSTOMS

Passengers' personal effects are admitted into Australia free of duty provided that they are the passengers' own property, are for their own use, and are not intended for sale, exchange, trade, or other commercial purpose. The importation of certain items such as narcotic drugs and weapons is strictly prohibited.

BUSINESS CENTRES AND INTERNET ACCESS

Many of the hotels (including the Parkroyal) as well as the Sydney Convention and Exhibition Centre have business centre facilities. In addition there is a Kinkos located at 117 York St. Sydney (ph 92836011) which offers 24Hr business services.
Some of these business centres also offer internet services, and there are a number of Internet Cafes in the vicinity of the convention centre including Hotel Sweeney's at 236 Clarence St. (ph (02) 9261 5666) and several establishments on George St. near Goulburn St.

CHILD CARE

- **Parkroyal** - Child care can be arranged through the Hotel with 'Dial an Angel', although not provided by the Hotel itself.
- **Novotel, IBIS and Grand Mercure Appts** - Babysitters can be arranged through the Hotel, and come to the room. Cost is A$14/hr before 6pm, and A$12/hr after 6pm. There is a A$16.50 booking fee for a minimum of 3Hrs.

IX. SYDNEY

Sydney, the gateway to Australia and the capital of New South Wales, is situated on one of the most beautiful harbours of the world. Sydney is the largest seaport in Australia and has a population of almost five million. The natural appearance of the foreshore has been preserved by the Harbourside National Park and the city itself is enlivened by gardens, pedestrian malls and fountains. Sydney's golden surfing beaches play a major role in the leisure and sporting lives of its people. To the east of the Harbour Bridge is one of Sydney's most famous landmarks - the Sydney Opera House. Under the approaches to the Bridge is the historic Rocks Area, where colonial buildings, customs and arts are preserved. Restaurants in Sydney reflect the spectacular diversity of our cultural origins.

X. DAY TOURS

Whilst visiting Sydney, you have a wonderful opportunity to explore and visit our beautiful surroundings. The following day tours, capturing the best of Sydney, have been designed especially for Conference delegates, family and friends. The Tour Desk will be located in the registration area and they will be happy to arrange additional tours. All tours are based on a minimum number of participants or with some tours there is a limit to the number of participants. If numbers are not reached, or exceeded, alternative arrangements or a complete refund will be made. Numbers are limited on some tours and places will be allocated strictly in order of receipt of bookings.
Important: All tours depart from the main entrance to the Sydney Convention and Exhibition Centre, Darling Harbour. All tour prices are inclusive of Goods and Services Tax (GST) of 10%.

CITY OF SYDNEY

Date: Monday 11th December, 2000
Time: 1:00pm – 4:00pm
Cost: A$55.00 per person
A special orientation tour featuring the world famous surfing beach at Bondi, the fashionable harbourside suburbs of Rose Bay and Double Bay, the bohemian district of Kings Cross and Paddington Village. A highlight of the tour is the ascent of Sydney Tower – the views are stunning.

NORTHERN BEACHES

Date: Thursday 14th December, 2000
Time: 1:00pm – 4:00pm
Cost: A$66.00 per person (includes morning tea)
Travel across the Sydney Harbour Bridge to the northern suburbs. Lookout for magnificent views over Middle Head, Beauty Point and the marinas in Pearl Bay and Middle Harbour. See the spectacular northern surfing beaches including Curl Curl, Freshwater, and Queenscliff. Visit the popular seaside resort of Palm Beach before returning to the city via world famous Manly Beach, lined with Norfolk Island pines.

CREATION OF AN OPERA

Date: Tuesday 12th December, 2000
Time: 9:00am - 12:30pm
Cost: A$77.00 per person (includes morning tea)
This morning visit Australia' s premier performing arts centre. Enjoy a tour of the Sydney Opera House, considered to be one of the 20th century's architectural triumphs. Morning tea will be served in one of the spectacular restaurants overlooking Sydney Harbour. Continue to the world renowned Australian Opera Company and take a glimpse behind the scenes on a tour of their workshops at Surry Hills. See virtually every production department, the props workshop; the Wardrobe section and the Arts Department where the jewellery, hats and hairpieces are produced.

XI. WORKSHOP DESCRIPTIONS and SCHEDULES

The workshops for the 2000 CDC will be held on Sunday, December 10th 2000 and Monday, December 11th 2000 in the Parkroyal Hotel, Darling Harbour, Sydney. The workshop descriptions and schedules are as follows:

WORKSHOP S-1 AND M-1: THE BEHAVIORAL APPROACH TO SYSTEMS MODELLING AND CONTROL

Jan Willems, University of Groningen
H.L. Trentelman, University of Groningen

Aim:

The aim of this workshop is to provide a mature and self-contained introduction to the behavioral approach to systems modelling and control. The ideas, motivation, and mathematical setting will be carefully explained, against the background of modelling procedures. System representations and their relation to system properties as controllability, observability, the state property, etc., will be discussed together with computer-algebra based algorithms for verifying these properties or obtaining various system representations. We will also discuss the relevance of these notions in control. In the behavioral approach, control is viewed as interconnection. The issue of (feedback) implementability will be addressed in this setting. Finally we will discuss stabilizability, and H_2 and H infinity control. This is based on the theory of dissipative systems and quadratic differential forms, and we will develop also this background material in the course.

Background:

The input/state/output approach for the analysis and synthesis of dynamical systems has enabled scientists and engineers to deal very successfully with a large variety of dynamical problems. However, the requirement to specify the input/output structure of a system is often awkward and inconvenient. This is very apparent in physical models obtained from first principles and, more generally, when modelling interconnected systems, based on `tearing' the system into subsystems and `zooming' in on the individual subsystems. A complete model is then readily obtained by a combination of (i) subsystem models and (ii) interconnection laws. Moreover, this procedure can be set up hierarchically. However the resulting models do not display the input/output structure that is required for the direct application of the usual techniques and algorithms of modern system theory. The shortcomings of the input/state/output approach for modelling and analysis of dynamical systems has become most apparent in these physics or computer based modelling procedures, for example, based on bondgraphs, modelling of multibody mechanical systems, computer assisted modelling software as MODELICA, SPICE, etc.

The behavioral approach offers a framework in which the benefits of these physical systems, first principles modelling, ideas are nicely combined with the `open' systems concepts of modern control. In the behavioral approach a dynamical system is simply viewed as a family of trajectories mapping the time axis into the signal space. The behavior is then simply a law that specifies which trajectories, according to the model, are allowed and which trajectories are forbidden. Most models contain auxiliary variables in addition to those the model aims at. These auxiliary variables occur for a number of reasons, and often, in fact, as the interconnection variables of a complex system. The behavioral approach offers many advantages from the modelling point of view, because of its compact way of specifying system parametrizations, and, last but not least the possibility of generalization, for example to systems described by partial differential equations.

Course Format:

The course will be given in a 2-day format, with 8 lectures of 90 minutes each. The plan is to present the course in a Powerpoint supported presentation. Copies of the presentation text and reprints or manuscripts with background material will be provided. The exposition will have the pedagogical character of a course, not a series of lectures with a common theme.

Workshop Outline: (Sunday 10th December and Monday 11th December)

Modelling interconnected systems, lecturer J.C. Willems

The notion of behavior of a system. Modelling, modularity and interconnection graphs. Relation with bondgraphs. Manifest and latent variables. Linearity, linearization, time invariance, symmetry. Application to electrical circuits, mechanical systems, etc.

System representations, lecturer, H.L. Trentelman

Representation of behaviors. Kernel representation, equivalent representations. Autonomous systems. Inputs and outputs. Controllable behaviors. Observability. Image representations.

Algorithms for elimination and state representation, lecturer J.C. Willems

Latent variable representations. The annihilation module. Elimination of latent variables. Computer algebra. State representation of behavioral systems. Algorithmic aspects.

Control as interconnection, lecturer H.L. Trentelman

Interconnection of behaviors. Control as interconnection. Regular interconnection and singular feedback. Control through specific terminals. Full plant behavior, hidden behavior and manifest plant behavior. Stabilizability. Implementability, including feedback implementability.

Simulation, lecturer J.C. Willems

Existence and uniqueness of solutions of higher order differential algebraic equations. Relation to index problems. Simulation of systems with specified exogenous variables and initial data.

Dissipative systems, lecturer H.L. Trentelman

Two-variable polynomial matrices. Bilinear and quadratic differential forms. Dissipativity, storage functions and dissipation functions. Polynomial spectral factorization. Every storage function is a state function. Pick matrices.

H_2 and H infinity control, lecturer H.L. Trentelman

H_2 and H infinity control in a behavioral framework. Synthesis of dissipative systems through interconnection. The H infinity control problem as the problem of finding an implementable dissipative subbehavior of the manifest plant behavior. Algorithmic aspects.

Systems described by PDE's, lecturer J.C. Willems

Constant coefficient partial differential equations. Elimination of latent variables. Controllability and observability. Potential functions. Grobner bases. Computer algebra for elimination and controllability.

WORKSHOP S-2: PREDICTIVE CONTROL IN INFORMATION TECHNOLOGY

Wolfram Ebert, Humboldt-University of Berlin

Workshop Description:

The workshop gives an overview and recent advantages of polynomial predictive controller and gives the theoretical background as well as implementation and tuning aspects. The goal of predictive controller presented here is the usage in Information Technology related applications. Especially network congestion control schemes demand a robust design due to unmodelled system dynamics and communication delay jitter. This robustness problem is addressed by an Internal Model Control scheme. Stability and robustness properties are also emphasized using a Space Crystal Furnace (MIMO) and a flexible transmission Benchmark example (SISO). Model based predictions are related to the accuracy of the underlying plant model. This model accuracy can be improved using a closed loop identification techniques. The relationship of robust control design and the corresponding uncertainty estimation is addressed by a Three Stage Identification (TSI) method. By usage of a stochastic model for network traffic an improved tracking accuracy of the data rate can be achieved. The corresponding parameter are determined using a real-time trace of MPEG video data. Finally, a simplified predictive congestion control scheme is presented which focus on a predictive TCP/IP protocol.

Workshop Timetable: (Sunday 10th December 2000)

8:00am-9:00am Introduction to generalized predictive control
9:00am-10:00am Predictive control with guaranteed stability (CRHPC,EWGPC,OWGPC)
10:15am-11:00am Proof of nominal stability
11:00am-12:00am Robustness framework (additive uncertainty, IMC)
1:00pm-2:00pm Closed loop identification (iterative design, LRPI for OWGPC)
2:15pm-3:00pm Stochastic predictive control (Kalman design)
3.00pm-4:45pm Predictive congestion control in communication networks

WORKSHOP S-3: NEW DIRECTIONS IN AUTOMATIC TUNING

Håkan Hjalmarsson, Royal Institute of Technology, Stockholm
Anders Hansson, Royal Institute of Technology, Stockholm
Michel Gevers, Université Catholique de Louvain
Jonas Sjöberg, Chalmers University of Technology

Workshop Description:

This workshop will focus on new directions in automatic tuning with a wide range of applicability in industry including PI/PID controllers and more general configurations. In particular the model free method, Iterative Feedback Tuning (IFT) will be presented. IFT complements traditional methods, is as easy to use, but is more flexible. The material ranges from basic principles and tuning of PI/PID controllers to more advanced applications such as tuning of multivariable controllers and handling of control constraints. The workshop includes several case studies. For one of these, hands-on experience is provided to the participants. Special attention is given to the user aspects of the tuning problem and design variables are thoroughly discussed. The workshop is suitable for control engineers from all fields but in particular process control. New researchers in the field, desiring an overview, can also benefit from the workshop.

Workshop Timetable: (Sunday 10th December 2000)

8:00am-9:00am New directions in automatic tuning
9:00am-10:00am Fundamentals of IFT
10:00am-10:15am Coffee break
10:15am-11:00am IFT for nonlinear systems
11:00am-11:30am Tuning of PID's
11:30am-1:00pm Lunch break
1:00pm-2.00pm User aspects: Time masking, Frequency weighting, Experiment design
2:00pm-3:00pm Computer exercise: Case study
3.00pm-3:15pm Coffee break
3:15pm-4:00pm Case studies continued.
4:00pm-5:00pm Advanced control topics: Multivariable systems, Robustness, Constraints, Sampled data systems, Non-linear controllers.

WORKSHOP S-4: TOWARDS A GENERAL THEORY OF HYBRID DYNAMICAL SYSTEMS

Andrey Savkin: University of Western Australia
Alexey Matveev: St. Petersburg State University, Russia

Workshop Description:

The aim of the workshop is to cover the recently obtained results on hybrid dynamical systems and the potential applications of these results. Hybrid dynamical systems (HDS) have attracted considerable attention in recent years. In general, HDS are those that consist of a logical discrete event decision-making system interacting with a continuous time process. A simple example is a climate control system in a typical home. The on-off nature of the thermostat is modelled as a discrete event system, whereas the furnace or air-conditioner are modelled as continuous time systems. Some other examples include transmissions and stepper motors, computer disk drives, robotic systems, high-level flexible manufacturing systems intelligent vehicle/highway systems, communication networks, interconnected power systems, air/sea traffic management. In fact, many problems facing control engineers, computer scientists, and mathematicians as they seek to use computers to control complex physical systems, naturally fit into the HDS framework. Study of HDS represents a difficult and exciting challenge to control engineering and is referred to as ``The Control Theory of Tomorrow'' by SIAM News.

Most of the workshop will concentrate on the classes of discretely controlled continuous-time systems. First, we will consider a quite general model of HDS called a differential automaton (DA). We will present results on algebraic reducibility (reduction to a finite-state automaton) of

DA, existence of limit cycles and their global asymptotic stability. An analog of the classic Poincare-Bendixon theorem will be given for planar DA. It will be shown, that under some assumptions, any DA can be represented as a product of a finite number of eventually periodic DA.
Our main results will describe a broad class of HDS that have a finite number of limit cycles and for which any trajectory converges to one of these cycles.Also, we will describe a broad class of HDS with chaotic behavior. We will apply these results to analysis and synthesis of complex switched flow server/arrival networks and dynamically routed queuing networks. Applications which will be considered include areas such as Flexible Manufacturing Systems and Communication Networks. Furthermore, we consider the problem of design of HDS via controller switching. Connections with the modern robust and H-infinity control theories will be shown. Finally, we will discuss the problem of optimal robust sensor scheduling. This very difficult class of estimation problems arises in applications such as robotics, command and control, and networked systems where an estimator is given dynamic control over measurements.

Workshop Outline: (Sunday December 10th 2000)

Simple classes of HDS:
Differential automata, linear cyclic differential automata, reduction to linear difference equations. Global stability of limit cycles. Examples of chaotic behavior.

General theory of differential automata:
Algebraic reducibility and decomposition of differential automata. Existence of limit cycles, their global asymptotic stability.

Planar differential automata:
An analog of the Poincare-Bendixon theorem for planar differential automata and its applications. Control of switched server/arrival systems.

Limit cycles in switched server networks:
Existence and stability. Examples.

Controllability and reducibility of complex multiple server switched networks:
Optimal control of flexible manufacturing systems. Applications to control of communication networks.

Design of hybrid systems via controller switching:
Robust and H-infinity control problems.

The problem of optimal robust sensor scheduling, open problems.

WORKSHOP S-5: MOTOR CONTROL PROBLEMS IN THE BRAIN

Hidenori H. Kimura, University of Tokyo
B. K. Ghosh, Washington University
L. Schovanec, Texas Tech University

Workshop Description:
In this workshop, we plan to introduce some basic control and systems problems in motor control. A central issue of systems neuroscience that we plan to discuss is how we transform sensory information into motor commands and how those commands are synthesized using a cellular architecture that give rise to algorithms interesting from the viewpoint of control theory. What, if any, are the roles of Cerebellum and Basal Ganglia in the process of co-ordination and learning? We also discuss the role of inverse dynamics, feedforward adaptive control, time-delay systems, visual feedback systems, nonlinear control, reinforcement learning and multi-model systems, some of which are recent focus of the control community.
Progress in deciphering the fundamental principles of motor control is increasingly dependent on systems-oriented engineering perspective that is closely integrated with experimental neuroscience. From an engineering perspective, it is important to analyze the operation of individual components in relation to the tasks that the nervous system as a whole is designed to carry out. A systems approach to this problem emphasizes the formulation and testing of explicit models of how different neural modules are designed and how they are integrated and coordinated to carry out their specific tasks. This would be the overall message of the workshop.

Workshop Timetable: (Sunday December 10th 2000)
8:30am-10:30am: Background (Kimura)
Historical Remarks , Basic Physiological Knowledge of Cerebellum and Basal Ganglia, Motor Control Architectures and Algorithms, Role of Models in Motor Control
10:45am-12:00am Muscle Dynamics and Control (Schovanec)
1:00pm-3:00pm Nonlinear Dynamics and Motor Control (Ghosh), Control Architecture with a Population of Neurons, Control of Eye and Arm Movements, Motion Prediction in the Visual Cortex
3:15pm-5:15pm Adaptation and Learning Problems in Motor Control (Kimura and Ghosh) Learning of Inverse Dynamics by Neural Networks, Memory and Model Building, Reinforcement Learning in Basal Ganglia
5:15pm-5:30pm Conclusion and Future Issues

WORKSHOP S-6: THE INTERPLAY OF PROBABILITY AND ROBUSTNESS FOR CONTROL OF UNCERTAIN SYSTEM

Giuseppe Calafiore, Politecnico di Torino
Fabrizio Dabbene, Politecnico di Torino
Boris Polyak, Russian Academy of Sciences
Roberto Tempo, Politecnico di Torino

Workshop Description:
The workshop concentrates on nonstandard tools for analysis and control of uncertain systems, with emphasis on the interplay of probability and robustness. The goal is to combine hard bounds, which are frequently used in classical robust control, with probabilistic information which is often neglected in this context. The main advantage is to provide additional insight to the control engineer. This insight may be very useful in analyzing and designing control systems in the presence of uncertainty.

The interplay of probability and robustness also leads to innovative concepts such as the probabilistic robustness margin and the probability degradation function. The algorithms obtained, usually referred to as Randomized Algorithms, are low complexity (polynomial-time) and are associated to robustness bounds which are generally less conservative than the classical ones, obviously at the expense of a small risk expressed in probability.
The workshop is focused on the exposition of the theoretical developments as well as on Matlab simulations showing the efficacy of these techniques. First, we present recent results for uniform sample generation in various norm-bounded sets of interest in robust control. In particular, we demonstrate how this task can be accomplished by means of methods used in statistical analysis and in the theory of random matrices. The construction of randomized algorithms using these samples concludes this part of the workshop. Secondly, we concentrate on probabilistic robust design and show how this problem can be formulated in the context of LQ Regulators. Then, we discuss how randomization and stochastic gradient methods can be successfully used in applications concerning set-membership identification and approximate feasibility of robust LMIs.
The workshop is concluded with a description of a number of open problems which may be important to consider in the near future.

Workshop Timetable: (Sunday December 10th 2000)

8:00am-9:00am Preliminaries and Motivations for a Probabilistic Approach (Tempo)
09:00am-10:00am Uncertain Systems and the Interplay of Probability and Robustness (Polyak)
10:00am-11:00am Randomized Algorithms (Dabbene)
11:00am-12:00am Sample Generation Theory and Examples - I (Calafiore)
12:00am-2:00pm Lunch Break
2:00pm-3:00pm Sample Generation Theory and Examples - II (Dabbene)
3:00pm-4:00pm Probabilistic Robust Design with LQ Regulators (Polyak)
4:00pm-5:00pm Applications: Robust LMIs and Estimation Problems (Calafiore)
5:00-pm-6:00pm Concluding Remarks and Discussion of Open Research Problems (Tempo)

WORKSHOP M-3: ACTIVE CONTROL OF NOISE AND VIBRATION

Hemanshu Roy Pota, The University of New South Wales
Ian R.Petersen, Australian Defence Force Academy, The University of New South Wales
S.O. Reza Moheimani, The University of Newcastle

Workshop Description:

Aim: The aim of the workshop is to enable the participants to firstly understand the basics and practical aspects of acoustical and vibrating systems and secondly to learn of the advanced control techniques used for active control of noise and vibration.
Target Audience: This workshop is targeted at the controls community. The workshop will enable the participants to set up cost-effective experimental facilities, learn enough about the modelling techniques, and get an exposure to where the effort in developing control techniques needs to be directed to solve practical noise and vibration control problems.
Course Description:
The course material is divided into three parts. The first part will cover the modelling for control of acoustical and vibrating systems. The second part will be on the state-of-the-art sensors and actuators for the control of these systems. The final part will present techniques of robust control in general and minimax LQG control in particular which can be used for the feeback control of noise and vibrations.

1. **Modelling:** The fundamental description of the acoustical dynamics is given by the wave equation and the vibrating structures are described by the Euler-Bernoulli equation. In many practical situations energy methods are also used to derive the system dynamic equations. An introduction to these PDEs and energy methods will be given first along with the analytical solutions for a few simple configurations will be given briefly with some attention to the characteristics of the resulting infinite-dimensional models. The difficulty of obtaining analytical solution for general configuration will be presented next. With the difficulty of obtaining analytical solutions in view approximate formulations like modal decomposition will be considered. These approximate formulations will be put in the setting of obtaining finite-dimensional models for control. In many situations it is convenient to obtain experimental input-output data. The final part of this session will introduce methods to obtain good finite-dimensional models from the input-output data.
2. **Actuators and Sensors:** Actuators and sensors are integral parts of any vibration and noise control system. Piezoelectric actuators and sensors have emerged as viable tools in active vibration and noise control systems. The piezoelectric effect was first discovered by Pierre Curie in 1883. He observed that some natural crystals, once placed in an electric field, undergo a physical distortion, and converseley, when a mechanical stress is applied to these materials they develop a charge distribution. The piezoelectric effect in natural crystals is very weak. Therefore, there are limitations in employing them as actuators and sensors for vibration control purposes. Recently, we have observed a tremendous progress in the field of materials science, which *inter-alia* has resulted in availability of inexpensive piezoelectric materials. These materials are capable of transforming mechanical energy into electrical energy and *vice verca* in an efficient way. Recently, there has been increasing interest in vibration control by shunt damping of piezoelectric actuators. The idea is to dissipate some of the mechanical energy of the structure that is transformed into electrical energy by shunting an impedance to a piezoelectric element. Laboratory experiments have proved this to be a promising method for suppression of vibrations. Most of the results that have appeared in the literature, however, are *ad-hoc*. A detailed analysis of this technique will be presented, and it will be shown that the problem can be converted into a feedback control problem, which, in turn, can be solved using standard techniques. Furthermore, it will be shown how an arbitrary impedance can be realized using a simple electronic circuit and a digital signal processing system such as dSPACE. Moreover, it will be explained that piezoelectric elements can be used directly as actuators and sensors to form a feedback loop. A detailed analysis of this technique will be given and examples based on real experiments will be presented.

Robust Control: Physically speaking acoustical and vibration systems are infinite-dimensional. However, most practical robust control system design tools are for finite-dimensional systems. Hence, it is common to model these systems as finite-dimensional systems with the residual dynamics treated as an uncertainty. Indeed, it has been found that for any noise or vibration feedback control system to work, (with the exception

of simple collocation controllers) , a robust control approach is essential. In this part of the course LQG and H-infinity control techniques, in the context of noise and vibration control, will be discussed. Furthermore, in order to fully address the issue of robustness, the issue of uncertainty modelling will be covered. From here, a recent robust controller design methodology referred to as minimax LQG control will be discussed together with its practical implementation on acoustical and vibration systems. This methodology combines key aspects on LQG and H-infinity control.

Summary: There is a great interest in this research area due to the increasing industry demand for lightweight and precise structures and noise free environments. This workshop will present both noise and vibration control from a unified approach starting from modeling and working towards robust feedback control. All of the three presenters have extensive experience both with the theory and experimental implimentation of noise and vibration control systems. This will enable presentation of the material tested in practice and founded on a unified study of distributed parameter systems. We expect to have a hardware demonstration during the workshop.

Workshop Timetable: (Monday 11, December 2000)

9:00am-11:00am Modeling of acoustical and vibrating systems - HR Pota
11:00am-11:15am Break
11:15am-12:15pm Actuators and sensors for control, e.g., piezoelectric materials - SOR Moheimani
12:15am-1:45pm Lunch Break
1:45am-2:45pm Actuators and sensors for control continued - SOR Mohmeimani
2:45am-3:00pm Break
3:00am-5:00pm Robust Feedback Control of acoustical and vibrating systems - IR Petersen

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WORKSHOP M-4: ALGEBAIC TOOLS FOR NONLINEAR SYSTEMS ANALYSIS AND DESIGN

Giuseppe Conte, University of Ancona.
Claude H. Moog, IRCCyN/CNRS.
Anna Maria Perdon, University of Ancona.
M.D. di Benedetto, University of l'Aquila and Univeristy of Rome
X. Xia, University of Pretoria

Workshop Description:

This workshop will present an up-to-date account of the algebraic approach to nonlinear system theory and of its development in the last years. Together with a number of results which are scattered in the literature, a self contained, comprehensive description of techniques and tools will be displayed that will provide a solution to some control problems which are not easily tractable by differential geometric or differential algebraic methods.

One of the distinctive characteristics which make the algebraic approach useful is its inherent simplicity. In comparison with the mathematical background needed for employing profitably differential geometric or differential algebraic methods, the knowledge required for using the tools presented in the workshop is, in fact, very limited. A significant example of this is offered by the way in which the notion of accessibility and the problem of linearization are dealt with. In both cases, a single tool, based on elementary differentiation of a function, namely the notion of relative degree, gives the key for carrying on a deep analysis and for characterizing relevant dynamical properties. From a didactic point of view, simplicity renders the algebraic approach a practicable and valid choice in teaching engineering courses on nonlinear control. The workshop emphasizes this aspect and is usable as a teaching aid. In addition, simplicity facilitates the development of efficient algorithmic procedures, which are relevant in solving concrete analysis and synthesis problems.

The tools and techniques of the algebraic approach are employed for solving a number of basic control problems, which are of practical interest in fields like robotics and control of general mechanical systems, as well as in process control. Feedback Linearization, Disturbance Decoupling and Noninteracting Control are recast within this approach.

Another positive quality of the algebraic approach is its wide applicability in the field of dynamical systems and control. Although only continuous-time systems are considered in the workshop, the tools and methods can be generalized to discrete-time nonlinear systems. Applications to time-varying systems are also possible as well as for systems with time-delays. With respect to other general methodologies, then, the algebraic approach appears to be more versatile and capable of going to the heart of the problem.

Only a basic knowledge of systems and control theory is required for attending the workshop, whose material is arranged in a self-explicatory way.

Workshop Timetable: (Monday 11, December 2000)

Morning: Methodology

8:00am-10:00am Preliminaries (G. Conte), Modelling (G. Conte)
10:00am-10:15am Break
10:15am-12:00am Accessibility (C.H. Moog) , Observability (C.H. Moog), Systems Structure (M.D di Benedetto)
12:00am-1:00pm Lunch

Afternoon: Applications to Control Problems

1:00pm-2:45pm Input / Output Linearization (A.M. Perdon), Noninteracting Control (A.M. Perdon)
2:45pm-3:00pm Break
3:00pm-4:00pm Input / State Linearization (C.H. Moog) , Disturbance Decoupling (A.M. Perdon)
4:00pm-5:00pm Output feedback (X. Xia)

WORKSHOP M-5: ITERATIVE LEARNING CONTROL: THEORY, DESIGN, AND APPLICATION

Kevin L. Moore - Utah State University
Eric Rogers - University of Southampton
Jian-Xin Xu - National University of Singapore
Richard Longman - Columbia University
Minh Phan - Princeton University
David Owens - University of Sheffield

Workshop Description:

Overview: This workshop presents a tutorial introduction to the topic of iterative learning control (ILC), a relatively new technique for improving the transient response and tracking performance of processes, machines, equipment, or systems that execute the same trajectory, motion, or operation over and over. The approach is motivated by the observation that if the system controller is fixed and if the system's initial operating conditions are the same each time it executes, then any errors in the output response will be repeated during each operation. These errors can be recorded during system operation and can then be used to compute modifications to the input signal that will be applied to the system during the next operation, or trial, of the system. In iterative learning control refinements are made to the input signal after each trial until the desired performance level is reached. Research in the field of iterative learning control focuses on the algorithms that are used to update the input signal.

Motivation of ILC: The classic example of an ILC application is a robotic manipulator performing spot welding in a manufacturing assembly line. For instance, such a manipulator might be programmed to wait in its home position until a door panel is moved into place. It then carries out a series of welds at pre-defined locations, after which it returns to its home position until the door panel is removed. The entire process is then repeated. Although robotic operations and manufacturing are obvious examples of situations in which a machine or process executes a given trajectory over and over, there are numerous other problems that can be viewed from the framework of repetitive operations. Indeed, ILC techniques have been successfully applied to solve a variety of control engineering problems, such as robotic manipulators, electric drives, chemical process systems such as batch reactors, aerodynamic systems, and others. When such systems are operated repetitively, or as a batch process, iterative learning control can be used to improve the system response from trial to trial.

Purpose of Workshop: The main objective of this workshop is to present the fundamentals of iterative learning control to systems and control researchers who may not be familiar with the concept. The expected audience includes engineers, scientists, postgraduate students, and academics. The workshop will describe several streams of ILC research from around the world and will provide participants with an overview of the current state-of-the-art in ILC, including basic ILC theory, current design practice, example applications, and research directions. A novel feature of the workshop will be a demonstration of the ILC design process applied to a ?live? laboratory-scale electromechanical system. Throughout the workshop the underlying theme will be ILC as an applicable design methodology with much scope for onward theoretical developments leading to actual implementations with clearly visible returns in terms of improved performance.

Workshop Structure: The workshop begins with an introduction to the basic ideas of ILC. Then, to provide a framework for analysis and design of learning control systems, the learnable control environment will be defined. This environment includes a periodic reference signal source, periodic disturbances and periodic dynamic behavior of the process. Next we will discuss the effectiveness and limitations of the two main approaches widely employed in learning control: the contraction mapping approach and energy function-based approaches. We will show that convergence properties and the applicability of the two approaches highly depend on our a priori knowledge of the system structure. We also discuss the effect of system structure on learnability in terms of the internal model principle. Next, the connection between ILC and other control methodologies will be explored, including adaptive control, optimal control, and system identification. This will be followed by a discussion of ILC for nonlinear systems and robotics. A related control methodology is repetitive control. It will be shown that ILC and repetitive control can be viewed as two sides of the same coin and practical design rules will be presented for both ILC and repetitive controllers. Following this discussion, a live lab demonstration will be given to illustrate the ideas presented in the workshop. The workshop then concludes with three final topics. First, the integration of learning control with other intelligent control approaches will be explored. The complementarity and additivity of a learning mechanism to other existing control mechanisms will be discussed. We will demonstrate three such cases: neural networks, learning variable structure control, and fuzzy logic learning control. Next, we consider new ILC research areas, including direct learning control of non-uniform/non-repeatable tasks and a formulation of general recursive learning control. Finally, we discuss the connections between ILC and iterative feedback tuning.

Workshop Timetable: (Monday 11, December 2000)

8:00am-8:15am Welcome and Introduction (Moore)
8:15am-9:00am Fundamentals of ILC (Moore) , Motivations , Generic Algorithms (Continuous and Discrete), Examples and Sample Applications
9:00am-9:45am Theory of LC in Repeatable Control Environment (Xu), Contraction Mapping-Based ILC, Energy Function-Based ILC, Learnability and System Structure, Predictive ILC (Owens)
9:45am-10:00am Break
10:00am-10:45am Adaptive Control and ILC (Rogers)
10:45am-11:30am Optimal Control, System ID, and ILC (Phan)
11:30am-12:15pm ILC for Nonlinear Systems (Xu)
12:15pm-1:30pm Lunch
1:30pm-2:15pm ILC Applied to Robotics (Longman)
2:15pm-3:00pm Repetitive Control and the Design of ILC Algorithms (Longman)
3:00pm-3:15pm Break
3:15pm-4:00pm Live Laboratory Demonstration(Moore/Phan)
4:00pm-4:30pm Integration of ILC and Intelligent Control (Owens/Xu), Iterative learning and other learning approaches, ILC and neural network ILC and fuzzy logic control, Learning variable structure control
4:30pm-5:00pm New ILC Research Areas (Xu), Direct learning control of non-uniform/non-repeatable tasks General recursive learning control
5:00pm-5:30pm ILC and Iterative Feedback Tuning (Rogers)

XII. PLENARY AND SPECIAL SESSIONS OF THE 39th IEEE CDC

The 39th IEEE Conference on Decision and Control continues a long and established record of high-quality technical programs. Of the 1,788 submissions to the conference, 986 papers were accepted and organised into 156 sessions and 13 parallel tracks. In addition to this strong technical program, the conference offers nine pre-conference workshops and six special plenary sessions. Following CDC tradition, each day highlights one of two plenary lectures, a plenary panel, or the Bode Lecture. Two special evening sessions of general interest round out the agenda. Detailed descriptions of the six special plenary sessions and speaker biographies follow.

Plenary Lecture I
Is the Model a Good Controller? – Perspectives on Brain Motor Control

Speaker: Professor Hidenori Kimura
University of Tokyo
Chairs: Professor Robert R. Bitmead
Univ. of California, San Diego
Professor Cheryl B. Schrader
Univ. of Texas at San Antonio

Harbourside Auditorium 2
Tuesday 12 December
8:30 – 9:30 am

ABSTRACT: (1) *From Model-based Control to Model-driven Control*
The most salient feature of modern control theory established in the early 1960's is its extensive use of a model of the plant for design of control systems. Unless a model of the plant is available, this theory is totally useless. In this sense, modern control is essentially model-based, implying that the model is a unique interface between theory and the real world. Various issues related to models and modeling in control have been extensively worked out in the last two decades. The availability of a plant model for control system design has motivated the use of models as components of controllers. Observers and Kalman filters use a copy of a plant model for operation when implementing a quasi-state feedback. The more explicit use of the model in the control configuration is seen in Internal Model Control and the variety of its versions. These controllers are not only model-based, but also model-driven in the sense that the models are directly involved in the architecture of the control systems. The role of the model is highly strengthened in model-driven control.

(2) *The Model as a Component of Controllers*
Then the problem arises: Is the model a good controller? We can approach this question from various aspects. It can be said that the involvement of models in control systems makes the control architecture intuitively clear, and thus enhances tunability in implementation. Robustness is another issue to be addressed.

(3) *Motor Control in the Brain*
Motor control is the task of the brain to move limbs, eyes, and neck voluntarily. The control is extremely smooth, versatile and even creative under severe hardware constraints. An architecture proposed by computational neuro-scientists is interesting model-driven adaptive control with the adaptive controller in the feedforward path. It can be said that the architecture exhibits a sort of ultimate use of models in control. The analysis of the architecture will answer the question: IS THE MODEL A GOOD CONTROLLER?

BIOGRAPHY: Hidenori Kimura graduated from the University of Tokyo in 1965, where he received the Doctor of Engineering Degree. He joined the Faculty of Engineering Science, Osaka University in 1970 where he was engaged in research and education in control theory and its applications for 25 years. In 1995, he moved to the Department of Mathematical Engineering and Information Physics at the University of Tokyo. He is now affiliated with the Department of Complexity Science and Engineering, the Graduate School of Frontier Science which was newly established. His research interests are the general theory of models and modeling, interplay between modeling and control, brain motor control and quantum mechanical control. He stayed in Warwick University and the Imperial College of Science and Technology in UK in the academic years 1974/75 supported by the British Council. He is a recipient of the Paper Awards from SICE (Society of Instrument and Control Engineers) in 1972, 1983, 1993, 1997, the Author's Award from SICE in 1998, the George Axelby Award from IEEE CSS in 1985, Paper Prize Awards from IFAC in 1984 and 1990, and the Distinguished Member Award from IEEE CSS in 1997. He was also elected Fellow of SICE in 1989 and of IEEE in 1990. He is engaged in the Editorship in many journals such as, Systems and Control Letters, International Journal of Control, Automatica, Journal of Nonlinear and Robust Control, Control Theory and Advanced Technology, and the Asian Journal of Control. He was a member of the Board of Governors of IEEE CSS for six years from 1991 and the General Chair of the CDC 1996 in Kobe. He is now a Vice President of SICE.

Plenary Lecture II
Visual Information in a Feedback Loop: A Control/Computer Vision Synthesis

Speaker: Professor Allen Tannenbaum
Georgia Institute of Technology
Chairs: Professor Cheryl B. Schrader
Univ. of Texas at San Antonio
Professor Robert R. Bitmead
Univ. of California San Diego

Harbourside Auditorium 2
Thursday 14 December
8:30 – 9:30 am

ABSTRACT: In this talk, we will outline some work on the development of novel techniques for employing visual information in control systems. This effort is leading to enhanced man-machine interfaces for interactions with computers and more complicated systems such as remote controlled weapons and vehicles. The approach is based on work in robust control as well as certain recent paradigms to treat various problems in image processing and computer vision utilizing the theory of geometric invariant evolution equations. Besides the control applications, these techniques are already being applied in medical imaging (MRI, CT, and ultrasound), as well as shape and object recognition problems (e.g., automatic target recognition). A major goal of this program is to ensure that the research is directly driven by applications, so that the results have a direct impact on industrial, military, and medical imaging problems. This synthesis of control and computer vision we call controlled active vision.
More precisely, let us consider the key research area of visual tracking, which may be employed for a number of problems in robotics, manufacturing as well as automatic target recognition. Even though tracking in the presence of a disturbance is a classical control issue, because of the critical aspect, the explicit combination of robust control techniques (to treat uncertainty), and the new approach to image processing has led to several novel visual tracking algorithms.

Indeed, controlled active vision has driven the need for the development of advanced algorithms in image processing and computer vision for a variety of uses: image smoothing and enhancement, image segmentation, morphology, denoising algorithms, shape recognition edge detection, optical flow, shape-from-shading, and deformable contours ("snakes"). Some of the newest methods are motivated by certain types of geometric invariant flows rooted in the mathematical theory of curve and surface evolution. There are now available powerful numerical algorithms based on Hamilton-Jacobi type equations and the associated theory of viscosity solutions for the computer implementation of this methodology. In this lecture, we will outline these ideas, and illustrate their utility on a wide variety of images. The talk will be directed to a general audience with an interest in control, vision and image processing.

BIOGRAPHY: Allen Tannenbaum was born in New York City in 1953. He received his Ph.D. in mathematics from Harvard in 1976. He has held faculty positions at the Weizmann Institute of Science, McGill University, ETH in Zurich, Technion, Ben-Gurion University of the Negev, and the University of Minnesota. He is presently the Julian Hightower Professor of Electrical and Biomedical Engineering at the Georgia Insitute of Technology. Dr. Tannenbaum has authored or co-authored over 230 research papers, and is the author or co-author of three books: Invariance and Systems Theory, Feedback Control Theory (with J. Doyle and B. Francis), and Robust Control of Infinite Dimensional Systems (with C. Foias and H. Ozbay). He also edited a volume with B. Francis in honor of Professor George Zames: Feedback Control, Nonlinear Systems, and Complexity. He is presently an Associate Editor of SIAM Journal on Control and Optimization and International Journal of Robust and Nonlinear Control. He is also on the Editorial Board of the new SIAM series of books in systems and control. He has done research in systems and control, computer vision, image processing, biomedical imaging, robotics, semiconductor process control, cryptography, operator theory, functional analysis, algebraic geometry, and invariant theory.

Bode Lecture
System Identification and Statistical Learning Theory: Can One Subject "Learn" from the Other?

Speaker: Professor Mathukumalli Vidyasagar
Tata Consultancy Services, Hyderabad

Chairs: Professor Tamer Başar, *University of Illinois, Urbana-Champaign*
Professor Robert R. Bitmead, *University of California, San Diego*

Harbourside Auditorium 2
Friday, December 15
11:00 am – 12:00 pm

ABSTRACT: System identification is a well-established branch of mathematics, engineering, and econometrics, while statistical learning theory is an equally well-established branch of probability theory, with recent contributions from computer scientists, neural networks researchers, and even system theorists. Though the set of researchers in the two fields is somewhat disjoint, it is nevertheless possible that one subject can "learn" from the other. The aim of this talk is to point out that indeed the two subjects are more closely related than might appear at first glance, and to suggest some interesting areas for future research. In particular, it is possible to formulate a single "general" problem that encompasses not only identification but also stochastic adaptive control, neuro-control, and learning control, all in a common framework. Moreover, thanks to recent advances in "pure" probability theory, this general problem is also tractable.

In both identification and learning theory, the objective is to make deductions about an unknown entity (the system to be identified and subsequently controlled, or as it is more commonly known, the plant) on the basis of experimental measurements which might be corrupted by noise. One begins with an *a priori* assumption that the unknown plant belongs to some plant family; without such an assumption, no algorithm will work. Ideally, the identification algorithm should yield both a nominal working plant model, as well as an estimate of how far the "true" plant might be from the nominal model. Though "uncertainty modelling" sounds like an oxymoron, it is an important part of designing a good controller.

In the early days of identification theory, the emphasis was on studying the *asymptotic* properties of algorithms, that is, their limiting behaviour. In recent times, some attempts have been made to derive "finite time" results in identification, which produce at each instant of time a set of plant models to which the true plants belongs. Examples of such approaches include worst-case identification theory, and the theory of non-falsifiable models. Unfortunately the estimates given by such methods are far too conservative, especially if the set of plant models is to be used to design robustly stabilizing controllers.

My philosophical objection to both of these approaches is that they are based on the rather pessimistic premise that mother nature is our adversary. In other words, it is assumed that at each time instant, the error in measurement is cunningly chosen by mother nature to make our lives as miserable as possible. I myself believe that nature is at best benign, and at worst indifferent, but never malicious. To put it another way, "in the long run" all measurement errors cancel out.

In contrast to identification theory, from the outset learning theory has been focused on deriving finite time estimates. Moreover, features such as uncertainty in the *order* of the unknown system are more easily handled in learning theory than in conventional ARMA model-based identification theory. As against this, traditional learning theory had no place for the notion of "time", since it was based on the premise that all measurements about the unknown system were statistically independent. This assumption is clearly violated when one is attempting to identify a dynamical system.

Recent advances in "pure" probability theory, especially the so-called theory of mixing processes, now allows one to combine both identification and learning into a common framework, whereby one can cope with a sequence of measurements that are statistically correlated, and at the same time, the plant class to which the unknown plant is assumed *a priori* to belong can contain systems of quite different dynamical order. This gives rises to optimism that it will soon be possible to prove some "grand" theorems that can address problems of system identification, stochastic adaptive control, and neuro-control, all within the same conceptual framework.

To summarize, the aim of this talk to present a meta-problem formulation which is now tractable, and which captures identification and learning formalisms in a common setting.

BIOGRAPHY: Mathukumalli Vidyasagar was born in Guntur, Andhra Pradesh, India on 29 September 1947. He received the B.S., M.S., and Ph.D. degrees, all in electrical engineering, from the University of Wisconsin, in 1965, 1967, and 1969, respectively. He has taught at Marquette University, U.S.A. (1969-70), Concordia University, Canada (1970-80), and the University of Waterloo, Canada (1980-89). In 1989 he returned to India as the Director of the Centre for Artificial Intelligence and Robotics, (under the Defence Research and Development Organisation) in Bangalore. In April 2000 he took up his current assignment as Executive Vice President (Advanced Technology) in the Tata Consultancy Services, which is India's largest IT firm. At present he is based in the city of Hyderabad. In his current position, his responsibilities are to oversee a team in developing compentences in the areas of secure networking, e- and m-commerce, and related technologies.

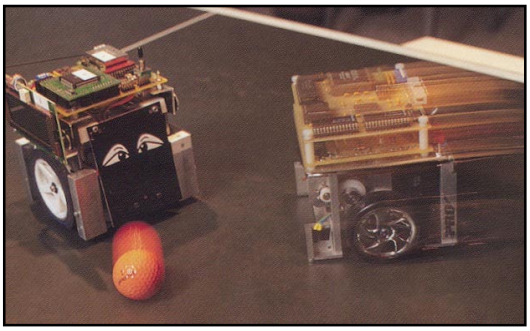
In the past, he has held visiting positions at several universities including M.I.T., California (Berkeley), California (Los Angeles), C.N.R.S. Toulouse, France, Indian Institute of Science, University of Minnesota, and Tokyo Institute of Technology. He is the author or co-author of seven books and more than one hundred and twenty papers in archival journals. He has received several honours in recognition of his research activities, including the Distinguished Service Citation from his Alma Mater (The University of Wisconsin). In addition, he is a Fellow of Institute of Electrical and Electronics Engineers (IEEE), the Indian Academy of Sciences, the Indian National Science Academy, the Indian National Academy of Engineering, and the Third World Academy of Sciences. His research interests are control theory, robotics, and machine learning.

Special Evening Session I
Reshaping Control Education for the 21st Century

Speakers: Professor Kishan Baheti
National Science Foundation
Professor Bonnie Heck
Georgia Institute of Technology
Professor Raffaello D'Andrea
Cornell University

Chairs: Professor Bonnie Heck
Georgia Institute of Technology
Professor Cheryl B. Schrader
Univ. of Texas at San Antonio

Harbourside Auditorium 2
Tuesday 12 December
7:00 – 7:50 pm



ABSTRACT: This special session will begin with a discussion of the challenges in reshaping control education for the 21st century workforce. Promising areas of development and projects of general interest will be examined. Activities of the IEEE CSS Technical Committee on Education and its role in advancing future thrusts in educational methods will be presented as well. The session highlight focuses on a concrete example of an innovative and interdisciplinary project entitled "The ROBO Files: Building the Best Soccer Team in the World."

Special Evening Session II
The Control Industry Transformed: A Supplier's Perspective

Speakers: Dr. Datta Godbole
Honeywell Technology Center
Dr. Greg Irving
Honeywell Australia
Dr. Hiran Vedam
Honeywell Singapore Laboratory

Chairs and Organisers:
Dr. Tariq Samad
Honeywell Technology Center
Dr. John Weyrauch
Honeywell Technology Center

Harbourside Auditorium 2
Tuesday 12 December
8:00 – 8:50 pm

ABSTRACT: Honeywell has always been recognized as a leading-edge control technology supplier and market leader in its various businesses: aerospace, homes,buildings, and industrial controls. As a consequence, the corporation has been both an agent of and subject to dramatic changes in the control industry over the last several years. These changes have been driven by many factors, including the information technology revolution and broader trends of globalization and industry consolidation. In this session, Honeywell participants will discuss how the company has been affected by, and how it is responding to, these changes in its three controls-related businesses. Particular emphasis will be given to future R&D priorities. By focusing on one company's strategies and developments across multiple application domains, the session should provide attendees a general appreciation, based on concrete examples, of the transformations in research and practice that are underway in the control industry.

Plenary Panel

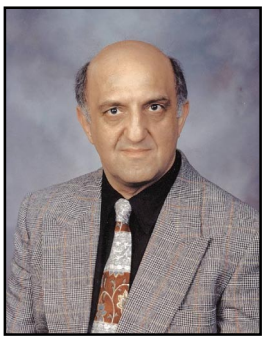
Control Theory Milestones: A Journey Through the 20th Century

Speakers: Professor Tamer Başar
Univ. of Illinois
Professor Petar Kokotovic
Univ. of California, Santa Barbara
Professor David Mayne
Imperial College of Science, Tech. and Medicine, London
Professor Alberto Isidori
Univ. di Roma "La Sapienza" and Washington Univ.
Chairs: Professor Tamer Başar
University of Illinois
Professor Cheryl B. Schrader
Univ. of Texas at San Antonio

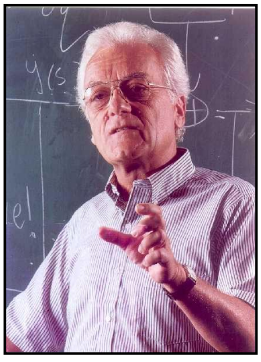
Harbourside Auditorium 2
Wednesday, December 13
5:00 – 6:20 pm

ABSTRACT: Control is in one sense a fairly young discipline. Even though it would be possible to push its historical origins back by about two millennia, to the days of the Babylonians, in modern terms the real creation of the field has been in the twentieth century. It is in this century that control became a scientific discipline, with an intellectual core shaped by revolutionary ideas, novel concepts, and a wealth of analytical and computational tools. As a young and intellectually stimulating discipline it attracted some of the brightest minds to its ranks, and with its theory driven by real applications it provided versatile tools for generations of practicing engineers.

We are now approaching the point of entrance into the year 2001, considered by some to be the real beginning of the twenty-first century. This juncture and the setting of the first CDC in the southern hemisphere provide an opportune occasion to reflect back and ask ourselves what the major research developments and accomplishments in control have been in the twentieth century, and particularly how control theory has evolved during its second half. This panel of four speakers will simply attempt to do this, guided by the soon-to-appear IEEE Press volume on Control Theory: Twenty-five Seminal Papers (1932-1981). The twenty-five chronologically ordered papers included in this collection embody the trend-setting accomplishments in control during the indicated fifty year period, and trace a path that characterizes the evolution of modern control theory. The speakers will follow this path and highlight the milestones that they encounter during this journey.



BIOGRAPHIES: Tamer Başar received B.S.E.E. degree from Robert College, Istanbul, in 1969, and M.S., M.Phil, and Ph.D. degrees in engineering and applied science from Yale University, in 1970, 1971 and 1972, respectively. After stints at Harvard University, Marmara Research Institute (Gebze, Turkey), and Bogazici University (Istanbul), he joined the University of Illinois at Urbana-Champaign in 1981, where he is currently the Fredric G. and Elizabeth H. Nearing Professor of Electrical and Computer Engineering, Research Professor at the Coordinated Science Laboratory, and Director of the Decision and Control Laboratory. Dr. Başar has authored or co-authored over 150 journal articles and book chapters, as well as numerous conference publications in the general areas of optimal, robust, and adaptive control; large-scale and decentralized systems and control; dynamic games; stochastic control; estimation theory; stochastic processes; information theory; and mathematical economics. On these topics, he has co-authored two books, with several editions, and edited several volumes. His current research interests are robust nonlinear and adaptive control, control of communication networks, risk-sensitive estimation and control, and robust identification.



Petar V. Kokotovic has been active for more than thirty years as control engineer, researcher and educator, first in his native Yugoslavia and then, from 1966 through 1990, at the University of Illinois, where he held the endowed Grainger Chair. In 1991 he joined the University of California, Santa Barbara where he directs the Center for Control Engineering and Computation. He has co-authored eight books and numerous articles contributing to sensitivity analysis, singular perturbation methods, and robust adaptive and nonlinear control. Professor Kokotovic is also active in industrial applications of control theory. As a consultant to Ford he was involved in the development of the first series of automotive computer controls and at General Electric he participated in large scale systems studies. Professor Kokotovic is a Fellow of IEEE, and a member of National Academy of Engineering, USA. He received the 1983 and 1993 Outstanding IEEE Transactions Paper Awards and presented the 1991 Bode Prize Lecture. He is the recipient of the 1990 IFAC Quazza Medal and the 1995 IEEE Control Systems Award.

David Mayne was born in South Africa and has held appointments at the University of the Witwatersrand, South Africa, the University of London, England, and the University of California, Davis. He received the degrees of Ph.D. and D.Sc. from the University of London and the degree of Doctor of Technology, honoris causa, from the University of Lund, Sweden. His research interests include optimization, model predictive control, nonlinear control and adaptive control. He is a Fellow of the Royal Society and a Fellow of the Royal Academy of Engineering

Alberto Isidori was born in Rapallo, Italy, in 1942. His research interests are primarily focused on mathematical control theory and control engineering. He graduated in electrical engineering from the University of Rome in 1965. Since 1975, he has been Professor of Automatic Control in this University. Since 1989, he is also affiliated with the Department of Systems Science and Mathematics at Washington University in St. Louis. He is the author of several books, including "Nonlinear Control Systems" (Springer Verlag), 1985, 1989 and 1995; "Nonlinear Control Systems II" (Springer Verlag), 1999. He is author of 80 articles in archival journals, of 16 book chapters and 86 papers in refereed conference proceedings, for a large part on the subject of nonlinear feedback design. He received the G.S.Axelby Outstanding Paper Award from the Control Systems Society of IEEE in 1981 and in 1990. He also received from the Automatica its Best Paper Award in 1991. In 1987 he was elected Fellow member of the IEEE "for fundamental contributions to nonlinear control theory." In 1996, at the opening of 13th IFAC World Congress in San Francisco, Dr. Isidori received the "Georgio Quazza Medal" for "pioneering and fundamental contributions to the theory of nonlinear feedback control".

XIII. IEEE CONFERENCES ON DECISION & CONTROL - PAST AND PRESENT

Following a tradition that started with the 1991 CDC, please find below the complete list of past CDCs with titles, chairs and locations. The CDC grew out of the former Symposium on Adaptive Processes, to become the premier conference in the field. Early on, it was associated with the Joint Automatic Control Conference (JACC - now called the ACC) and later the National Electronics Conference (NEC). In the following listing, GC denotes General Chair, PC stands for Program Chair, and SC is Symposium Chair. The proceedings of all past conferences can be found at the IEEE Library, 345 47th Street, New York, NY 10017.

DISCRETE ADAPTIVE PROCESSES: SYMPOSIUM AND PANEL DISCUSSIONS (IEEE)

part of 3rd JACC
GC: J. Sklansky
New York University, New York City, NY
29 June 1962

SYMPOSIUM ON ADAPTIVE PROCESSES

part of NEC
GC: L. Kanal
McCormick Place, Chicago, IL
28-29 October 1963

SYMPOSIUM ON ADAPTIVE PROCESSES

part of NEC
GC: F.J. Mullin
McCormick Place, Chicago, IL
19-21 October 1964

SYMPOSIUM ON ADAPTIVE PROCESSES

part of NEC
GC: E.C. Jones, Jr.; PC: G. Brown
McCormick Place, Chicago, IL
25-27 October 1965

SYMPOSIUM ON ADAPTIVE PROCESSES

part of NEC
GC: F.N. Bailey; PC: J.C. Hancock
McCormick Place, Chicago, IL
3-5 October 1966

SYMPOSIUM ON ADAPTIVE PROCESSES

part of NEC
GC: F.M. Waltz; PC: P.E. Mayes
International Amphitheater, Chicago, IL
23-25 October 1967

IEEE SYMPOSIUM ON ADAPTIVE PROCESSES

GC, PC: J.M. Mendel
UCLA, Los Angeles, CA
16-18 December 1968

IEEE SYMPOSIUM ON ADAPTIVE PROCESSES

GC: J.B. Lewis; PC: G.J. McMurty
Pennsylvania State University, PA
17-19 November 1969

1970 SYMPOSIUM ON ADAPTIVE PROCESSES (9TH) DECISION AND CONTROL

GC, PC: D.J. Lainiotis
University of Texas at Austin, Austin, TX
7-9 December 1970

1971 IEEE CDC

including the 10th SYMPOSIUM ON ADAPTIVE PROCESSES
GC: J.T. Tou; PC: S.K. Mitter; SC: J.M. Mendel
Americana Hotel, Miami Beach, FL
15-17 December 1971

1972 IEEE CDC

including the 11th SYMPOSIUM ON ADAPTIVE PROCESSES
GC: J.M. Mendel; PC: Y.C. Ho; SC: G.N. Saridis
Fontainebleau Motor Hotel, New Orleans, LA
13-15 December 1972

1973 IEEE CDC

including the 12th SYMPOSIUM ON ADAPTIVE PROCESSES
GC: J.S. Meditch; PC: D.G. Luenberger; SC: L.A. Gerhardt
Sheraton-Harbor Island Hotel, San Diego, CA
5-7 December 1973

1974 IEEE CDC

including the 13th SYMPOSIUM ON ADAPTIVE PROCESSES
GC: Elliott Axelband; PC: Stephen Kahne
SC: David P. Lindorff
Del Webb's Towne House, Phoenix, AZ
20-22 November 1974

1975 IEEE CDC

including the 14th SYMPOSIUM ON ADAPTIVE PROCESSES
GC: J.B. Cruz, Jr.; PC: J.B. Pearson; SC: G. Stein
Hyatt Regency Houston, Houston, TX
10-12 December 1975

1976 IEEE CDC

including the 15th SYMPOSIUM ON ADAPTIVE PROCESSES
GC: M. Athans; PC: E.R. Barnes; SC: T. Pavlidis
Sheraton-Sand Key Hotel, Clearwater, FL
1-3 December 1976

1977 IEEE CDC

including the 16th SYMPOSIUM ON ADAPTIVE PROCESSES
GC: K.S. Fu; PC: H. Sorenson; SC: T. Pavlidis
Fairmont Hotel, New Orleans, LA
7-9 December 1977

1978 IEEE CDC

including the 17th SYMPOSIUM ON ADAPTIVE PROCESSES
GC: Robert E. Larson; PC: Alan S. Wilsky
SC: Jerry M. Mendel
Islandia Hyatt House Hotel, San Diego, CA
10-12 January 1979

18TH IEEE CDC

including the SYMPOSIUM ON ADAPTIVE PROCESSES
GC: Stephen Kahne; PC: Alexander H. Levis; SC: Yaakov Bar-Shalom
Galt Ocean Mile Hotel, Ft. Lauderdale, FL
12-14 December 1979

19TH IEEE CDC

including the SYMPOSIUM ON ADAPTIVE PROCESSES
GC: Pierre R. Belanger; PC: David L. Kleinman
SC: Richard V. Monopoli
The Regent Hotel, Albuquerque, NM
10-12 December 1980

20TH IEEE CDC

including the SYMPOSIUM ON ADAPTIVE PROCESSES
GC: William R. Perkins; PC: Abraham H. Haddad;
SC: Kumpati S. Narendra
Vacation Village Hotel, San Diego, CA
16-18 December 1981

21ST IEEE CDC

GC: Alexander H. Levis; PC: William S. Levine
Holiday Inn - International Drive, Orlando, FL
8-10 December 1982

22ND IEEE CDC

GC: James L. Melsa; PC: Steven I. Marcus
Marriott Hotel, San Antonio, TX
14-16 December 1983

23RD IEEE CDC

GC: Abraham H. Haddad; PC: Michael P. Polis
Las Vegas Hilton, Las Vegas, NV
12-14 December 1984

24TH IEEE CDC

GC: Gene F. Franklin; PC: Anthony N. Michel
Bonaventure Hotel and Spa, Ft. Lauderdale, FL
11-13 December 1985

25TH IEEE CDC

GC: Anthony Ephremides; co-GC: Spyros Tzafestas;
PC: H. Vincent Poor
Atheneum Intercontinental Hotel, Athens, Greece
10-12 December 1986

26TH IEEE CDC

GC: William S. Levine; PC: John Baillieul
Westin Century-Plaza Hotel, Los Angeles, CA
9-11 December 1987

27TH IEEE CDC

GC: Michael P. Polis; PC: William E. Schmitendorf
Hyatt Regency Austin on Town Lake, Austin, TX
7-9 December 1988

28TH IEEE CDC

GC: Leonard Shaw; PC: Tamer Başar
Hyatt Regency Tampa Hotel, Tampa, FL
13-15 December 1989

29TH IEEE CDC

GC: Charles J. Herget; PC: Raymond A. DeCarlo
Hilton Hawaiian Village, Honolulu, HI
5-7 December 1990

30TH IEEE CDC

GC: Derek Atherton; PC: Panos J. Antsaklis
Metropole Hotel, Brighton, England
11-13 December 1991

31ST IEEE CDC

GC: Tamer Başar; PC: Sergio Verdu
Westin La Paloma, Tucson, AZ
16-18 December 1992

32ND IEEE CDC

GC: Raymond A. DeCarlo; PC: Peter Ramadge
Marriott Rivercenter, San Antonio, TX
15-17 December 1993

33RD IEEE CDC

GC: Michael K. Masten; PC: N. Harris McClamroch
Buena Vista Palace, Lake Buena Vista, FL
14-16 December 1994

34TH IEEE CDC

GC: Panos J. Antsaklis; PC: Edward W. Kamen
New Orleans Hilton Riverside, New Orleans, LA
13-15 December 1995

35TH IEEE CDC

GC: Hidenori Kimura
Co-PCs: Katsuhisa Furuta, J.Douglas Birdwell
Portopia Hotel and International Conference Center, Kobe, Japan
11-13 December 1996

36TH IEEE CDC

GC: Anthony N. Michel; PC: Theodore E. Djaferis
Hyatt Regency San Diego, San Diego, CA
10-12 December 1997

37TH IEEE CDC

GC: J. Douglas Birdwell, PC: David A. Castanon
Hyatt Regency Westshore, Tampa, FL
16-18 December 1998

38TH IEEE CDC

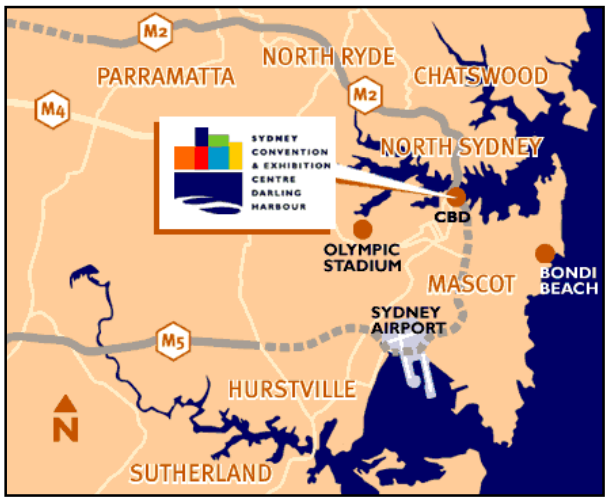
GC: Edward W. Kamen; PC: Christos G. Cassandras
Crowne Plaza Hotel and Resort, Phoenix, AZ
7-10 December 1999

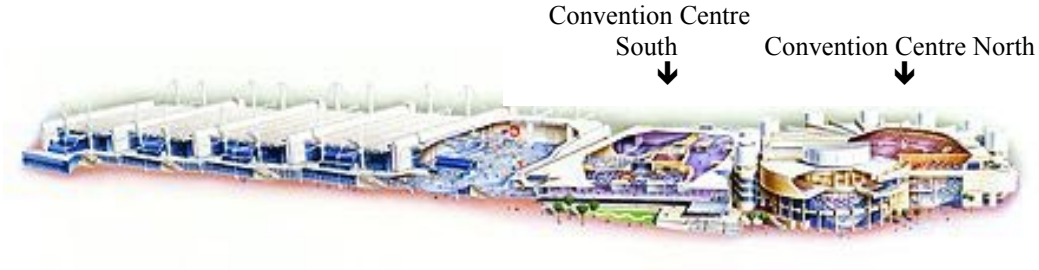
39TH IEEE CDC

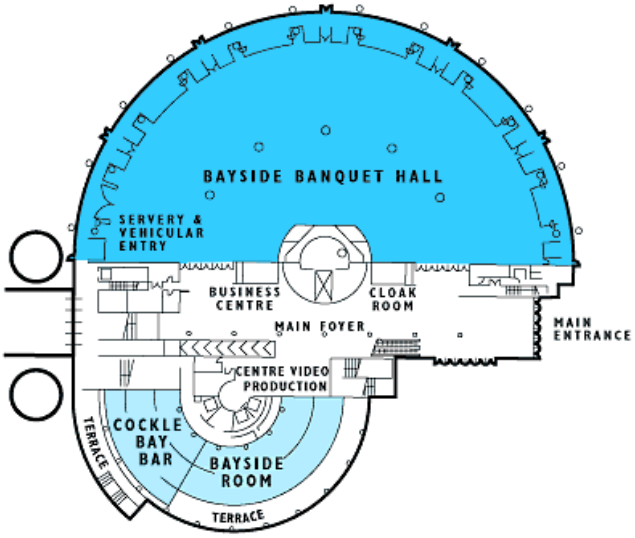
GC: Robert R. Bitmead; PC: Cheryl B. Schrader
Sydney Convention and Exhibition Centre, Sydney, NSW
12-15 December 2000

XIV. THE CONFERENCE VENUE AND MAPS

The Conference is being held in Sydney's premier conference venue, the Sydney Convention and Exhibition Centre. It is within walking distance of the Central Business District, shopping complexes and restaurants.







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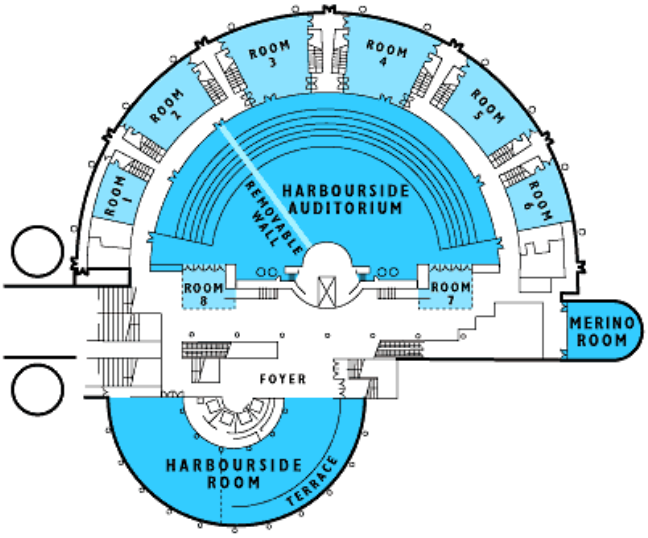

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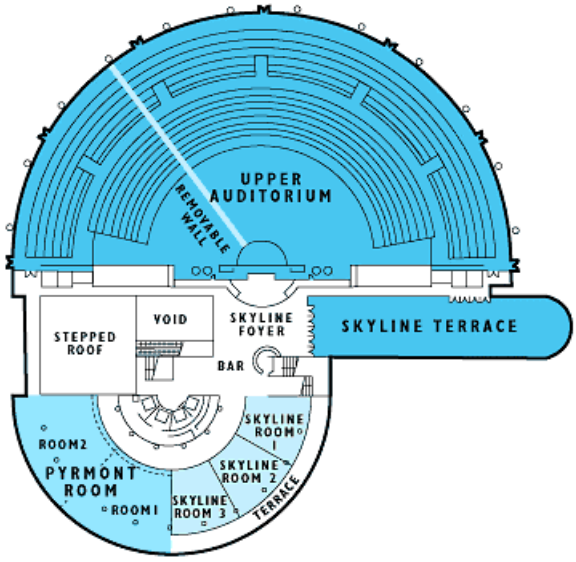

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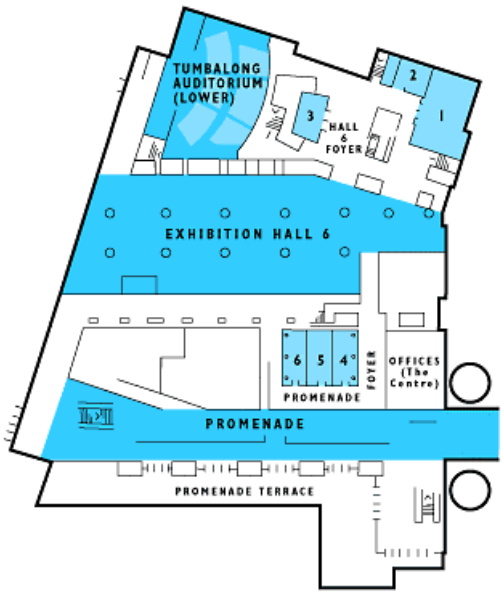

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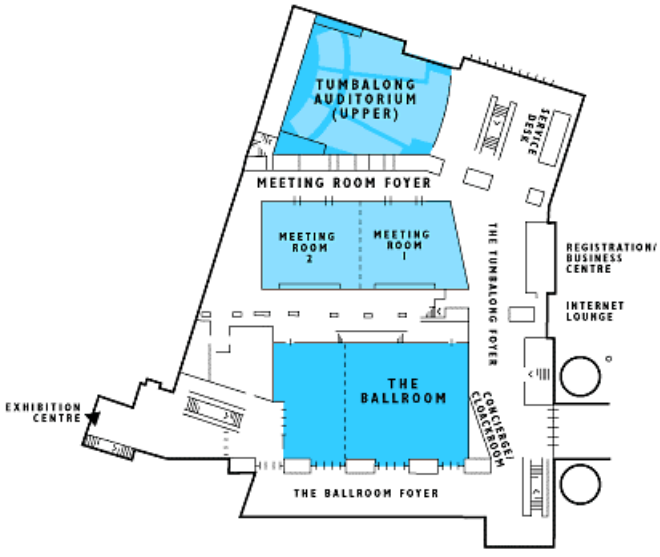

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